Chapter 5
MANAGEMENT PRACTICES

INTRODUCTION

This chapter is intended to provide an understanding of the quantitative and qualitative information that is readily available about the extent of management practices being implemented to reduce impacts on water quality resulting from irrigated agriculture and wetland management. The information in the chapter represents a snapshot of ongoing actions being conducted by irrigators and wetland managers to reduce impacts on water quality.

Organization

The chapter is organized as follows:

- The "Irrigated Lands Management Practices" section of this report provides information on the issues that would be addressed by various management practices, a discussion of various practices, and information on efforts to implement management practices.
- The "Wetland Management Practices" discussion is divided into three sections: the Sacramento Valley Subbasins, the San Joaquin Valley Subbasins, and the Tulare Lake Subbasins. These sections describe the managed wetlands and water supplies found in each subbasin; and provide information on water quality constituents of concern, current management practices, and the available water quality information for each subbasin. A general discussion of managed wetlands follows the subbasin information.

IRRIGATED LANDS MANAGEMENT PRACTICES

Sources of Information and Data

The approach used to prepare this section of the chapter was to conduct a phone survey to coalitions, commodity groups, and farm advisors to obtain quantitative and qualitative information about management practices being implemented. Questions also were asked about ongoing research and implementation barriers. Sources used to compile this information included the water quality coalitions, University of California (UC) Extension, and crop commodity groups that provide technical information to their members.

All of the individuals contacted for the phone survey were aware of the ILRP, and all but one contact was participating in the program at some level. Most of the individuals contacted were providing technical support to growers or working on the administration of coalition activities. Only one contact was directly involved in on-the-ground implementation of management practices. As noted, the information reported represents a snapshot of current efforts.

A recent noticeable change in implementing management measures is the availability of quantitative data and information. A few coalitions have begun to use geographic information systems (GIS) to monitor implementation of management practices, and the use of databases for organizing information has increased. Although these efforts are useful, it must be stressed that overall very little data concerning implementation of management practices are available. Other than an indicator such as the number of water quality violations, the effectiveness of the practices that have been implemented typically is not monitored. Although many state-funded projects contain monitoring components, there has been no review of that information to report.

Legal and Regulatory Requirements

Pursuant to the NPS Program Plan, the Regional Boards must implement programs to ensure that dischargers are following management measures. The management measures that apply to discharges from irrigated agriculture include specific steps for erosion and sediment control, nutrient management, pesticide management, and irrigation water management. Under this program, the manager of an irrigated field is expected to adhere to appropriate management practices designed to control potential releases of multiple pollutants. Individual landowners, or growers, are ultimately responsible for implementation of any Regional Quality Control Board Nonpoint Source Program requirements.

Water Quality Constituents

Improving water quality is based on reducing or eliminating waste constituents that could cause impairment to beneficial uses. The constituents that are addressed in this report vary by watershed but are categorized as follows:

- **Sediment**—Transported and deposited particles or aggregates derived from rocks, soil, or biological material. There are two primary concerns for sediment: its ability to bind chemicals, and the physical impacts caused by deposition.
- **Pesticides**—Natural or synthetic chemicals used to control pests and unwanted vegetation.
- **Nutrients**—Natural or synthetic elements or compounds that are essential materials for organism growth and development.
- **Native**—Compounds resulting from use of land and water resources. In the Central Valley, the primary native constituents of concern include boron, selenium, dissolved organic carbon (DOC), and salinity.
- **Pathogens—**Bacteria resulting from the application of animal waste to lands that are irrigated and from animals grazing on irrigated pastures.
- **Salts---**Salts are naturally occurring and move into the Central Valley through imported irrigation water & rivers. Evaporation of irrigation water and plant transpiration concentrates salts in the soil.

Each constituent has unique chemical and physical properties, and responds differently to biological activity; therefore, constituents can move and remain effective in different ways. These properties—solubility, adsorption, volatility, and persistence—are discussed below.

- **Solubility**—The amount of constituent that can dissolve in water. Highly soluble constituents dissolve in and flow with water, and are often referred to as “mobile” constituents.
- **Adsorption**—The attachment or adsorption of a constituent to a soil particle. The strength of attachment varies by constituent type. Constituents that are attached to soil particles will move with the particle.
- **Volatilization**—The process of a substance changing from a solid or liquid to a vapor. The volatilization of a constituent is a function of the constituents’ chemical properties and its exposure to environmental factors such as relative humidity, temperature, and wind speed. For example, low relative humidity, high temperatures, and high wind speed favor volatilization.
- **Persistence**—The ability of the constituent to remain in the environment for long periods. Many constituents are stable in the environment and have particularly long half-lives while other constituents are more readily converted to breakdown products through microbial degradation, hydrolysis, or thermal processes.

Based on their properties, constituents can move from the place of application in three basic ways—moving with surface water runoff in solution or attached to soil particles, through percolation into the groundwater, and moving with air flow as drift. The following is a summary of the ways in which constituents move.

- **Moving with runoff in solution or attached to soil particles—**Soluble constituents will move with runoff and can affect the receiving water body. Constituents adsorbed to soil particles can be transported from the place of application on sediments and can affect the receiving water body.
- **Deep percolation**—Movement of constituents into the groundwater. Soluble constituents, in applied irrigation water and surface runoff, can percolate to groundwater. While adsorbed constituents do not move to groundwater, persistent adsorbed constituents can eventually move to groundwater and cause more serious long-term contamination issues. DDT is an example of a persistent legacy pesticide that adsorbs to soil particles and can be found in groundwater.

- **Drift**—Movement of a constituent as a vapor or as particles. The primary factor causing drift is the method of application and the environmental conditions when the constituent is applied.

Dissolved constituents and constituents adsorbed to sediment can affect receiving waters. Factors that affect the movement of constituents to surface waters include timing and intensity of rainfall, irrigation method, timing of chemical application, soil type, slope, and type of soil covering. Constituents can affect groundwater directly or indirectly. Direct or point source impacts occur from site-specific spills or preparation areas. Indirect or nonpoint-source impacts occur from deep percolation in areas where the constituent is applied or where surface water recharges groundwater.

MANAGEMENT PRACTICES

Management practices, best management practices, and management measures are all various ways of describing how growers and other responsible parties pursue stated objectives. In some cases, a practice or group of practices is pursued solely to lower production costs. In other cases, a practice is implemented to address a specific objective, such as a reduction in storm water discharge. For this discussion, it is assumed that the implemented management practices are intended to reduce or eliminate negative impacts on water quality.

Actions taken to prevent or reduce impacts on water quality include physical and operational changes (management and policies) as well as educational efforts. Physical changes include modification of irrigation and drainage systems at both the on-farm and district level. Typically, infrastructure improvements are accompanied by operational or management changes. At the district level, operational changes include implementation of delivery policies that enable more flexible on-farm use and restrictions on return flows and drainage. At the farm level, a great number of actions can be implemented to reduce impacts on water quality, as discussed in further detail in this section.

In irrigated agriculture, district operations and surface irrigation methods are the two primary actions that lead to surface runoff. Management practices implemented to improve district operations include investments in regulating reservoirs, canal automation, interceptor systems, and increased labor. These actions give a water supplier greater control over its operations and allow the end user to better match their crop water needs with the available supply. District improvements are not typically implemented to improve water quality, but they do directly affect the ability of the end user to manage their system to reduce impacts on water quality. Similarly, end users are investing in technologies that utilize district improvements and provide greater control over the use of water. These technologies generally result in higher uniformity of irrigation that in turn reduces the impacts on water quality from nutrients and pesticides. In addition, the higher level of management used with these systems typically results in less surface runoff.

Crop type, physical setting, and economics drive the selection and implementation of management practices used to support production systems. For a given crop rotation, the physical setting—particularly water availability and the slope of the land—is a primary determinant in selecting the type of on-farm irrigation and drainage system to use. The selection of other practices, such as cover cropping, nutrient and pesticide management, harvesting, and cultivation, is driven by economics and agronomic needs.

Proven Management Practices

This section provides a summary of the management and hardware actions that have been proven to provide a water quality benefit. The practices are presented under the management categories identified by the State Water Board: erosion and sediment control, nutrient management, pesticide management, irrigation water management, and education and outreach. The single most comprehensive reference for individual management practices is the NRCS (http://www.nrcs.usda.gov/technical/ECS/). This website lists over 100 proven practices that provide information for physical actions that apply to several of the management measure categories. Although the NRCS guides were developed for general use, they contain sufficient guidance for local implementation.

In nearly all cases, there is no quantified information regarding the amount of benefit received from implementing the action. However, where quantified information is available, it is provided. When reviewing this section, one is advised that the application of any action will be specific for the site and how the action is managed. Therefore the potential outcome of any action cannot be guaranteed.

A considerable amount of information exists concerning practices that have been proven to reduce impacts on water quality. In controlled studies, for example, the use of cover cropping has been shown to reduce the amount of sediment running off a production field. Although these practices have been proven effective in reducing impacts on water quality, it is not appropriate to assign a management practice to a particular situation without a comprehensive understanding of its applicability as well as the costs and benefits.

Guidance information regarding management practices is available in numerous formats from a multitude of sources. County-level agricultural extension offices (http://ucanr.org/ce.cfm) typically provide publications concerning crop-specific management practices, such as alternative strategies for the application of annual dormant spray on tree crops. Information also is available for such site-specific issues as reduction of erosion in the Yolo Basin through use of vegetated waterways.

Other guidance information is broad reaching, such as the recommendation to use pressurized irrigation systems over surface irrigation methods. The reader should note that, in some instances, management practices also could be considered a treatment process. A good example is the use of tailwater ponds to capture and reuse surface runoff. Properly managed, this practice can eliminate sediment in discharge waters; and the ponds can serve as holding basins for storm water runoff that may contain dormant spray residue. Another consideration concerning management practices is the potential for redirected impacts. For example, the use of cutback irrigation to reduce surface runoff may result in greater impacts on groundwater. The remainder of this section is a discussion of proven practices.

Erosion and Sediment Control

Management practices for erosion and sediment control are designed to prevent movement of soil aggregates into receiving waters. The basic strategy is to slow the water down to a point where soil aggregates settle out or to prevent soil aggregates from entering into irrigation water. Retaining soil aggregates through use of cover cropping or mulching prevents sediment movement into irrigation water. Increasing infiltration also reduces runoff and movement of soil aggregates. Another approach to reducing the offsite movement of soil aggregates is to physically stop the sediment through filter strips, laser leveling fields, sediment traps, vegetated waterways, windbreaks, and polyacrylimides. The Yolo Resource Conservation District (RCD) (Yolo Resource Conservation District 2002) found that use of cover cropping reduced sediment loading by 46 percent compared to a fallow field. Another finding by the Yolo RCD was that sediment traps captured between 60 and almost 90 percent of suspended sediment. Specific practices related to erosion and sediment control that have been implemented at some level include:

- **Water and sediment control basins**—Constructed earth embankments or a combination ridge and channel that are constructed across slope and minor watercourses to form a sediment trap and water detention basin.
- **Temporary water checks**—Installed on the head or tail end of the field with the primary purpose of slowing down water.
- **PAM applications**—Polymers added to irrigation water at the head end of a field supply ditch or discharge point. Applications of 5–8 lbs/acre are typically metered with a gandy-type applicator. Several field trials have shown a 95-percent reduction in erosion from the use of PAM.
- **Tailwater return systems**—Essentially, large catchment ponds that prevent movement of sediment offsite. They are typically located at the low point in the field and must be maintained if used to trap sediment. These systems also can provide improved water management.
- **Tailend berms**—Constructed earthen berms that slow down water, allowing sediments to settle out. These can replace tail-end “V” ditches.
- **Sediment traps**—A variation on tailwater pond and berms. The traps are typically located on the tail end of a field and must be maintained.
- **Enhanced field drains**— A structural modification of the hydraulic performance of field drains. Changes to the hydraulic performance of field drains can decrease the velocity of runoff, allowing finer soil particles to settle out before discharge.
- **Cultural practices**—Practices used by growers to manage cropping systems. Cultural practices involve tillage operations, such as planting, weed control, plowing, ripping, disking, aerating, and harrowing, that are designed to loosen soil, direct water flow, and encourage vegetation growth. If properly conducted, tillage can dramatically reduce runoff and increase infiltration. The effects of tillage on offsite sediment movement largely depend on the specific tillage technique used, soil type, slope, soil organic matter, and a number of other site-specific factors. Improper tillage can compact soil, reduce soil organic matter, damage soil structure, and reduce the amount of infiltration during irrigation and storm events. Also, breaking up soil aggregates makes finer particles more available to move with the water.
- **Vegetated drainage systems**—Using vegetation in drainage systems that are a part of existing agricultural landscape features. Vegetated drainage ditches can be incorporated into a management program to help prevent offsite movement of sediments, nutrients, and pesticides with return flow and storm water runoff. Various vegetation management practices have the potential to slow the erosive speed of runoff thereby reducing pesticide runoff by increasing soil infiltration; accelerating pesticide degradation at the soil surface; and preventing the offsite movement of soil, nutrient, and pesticides during winter storm events.
- **Irrigation system hardware**—Hardware for three main types of irrigation systems: sprinkler, micro-irrigation, and surface. The type of irrigation system chosen is the result of many factors, including crop type and rotation, topography, water supply, soil type, delivery system capabilities, and cost. The type of irrigation system used, in combination with the implemented management, can determine the potential for surface runoff and the amount of sediment running off a field. Under proper management, little or no runoff usually is associated with sprinkler and micro-irrigation systems.

- **Windbreaks**—Often occurring as rows of trees, bushes, hay bales, or other obstruction, this practice reduces wind-driven erosion.
- **Filter Strips**—Land areas of either planted or indigenous vegetation, situated between a potential, pollutant-source area and a surface-water body that receives runoff that reduce the amount of sediment, organic matter, and some nutrients and pesticides, before the runoff enters the surface-water body. Filter strips also provide localized erosion protection since the vegetation covers an area of soil that otherwise might have a high erosion potential.

  Proper management of surface irrigation methods (basin, furrow, border) has the most potential for reducing the impacts on water quality through reduced runoff. Although some surface systems require runoff to achieve uniform distribution, structures (such as tailwater recovery systems) can be put in place to increase efficiency, reduce runoff, and trap sediments. Other surface irrigation practices that can reduce runoff include level basins, surge irrigation, and cutback irrigation, as summarized below:

  - **Level basins**—These are basins that are graded to zero slope (sometimes laser leveled) and have no outlet or drain and thus no runoff. For high irrigation uniformity, these systems require large flow rates. Although this method of irrigation is efficient, it would be difficult to convert existing systems to this method because of the high flow rates required.
  - **Surge irrigation**—These systems advance the wetting front down furrows by pulsing the water. The objective is to optimize the infiltration rate and thus to reduce surface runoff.
  - **Cutback irrigation**—After the irrigation water has progressed a pre-determined length of field, a cutback in flow rate is made. Although this method requires more field labor, the cutback step reduces the total volume of runoff and slows the water down, thus allowing sediment to fall out.

Nutrient Management

The basic management practice in this category is using a nutrient management plan to optimize the use of nutrients. The plan should identify the physical boundaries and features of the field, maintain records about the existing nutrient resources within the field, and identify the nutrient needs of the crop. When planning the use of nutrients, the timing of application must be considered to ensure that the rate of application meets the crop needs and does not lead to leaching losses or field runoff. A nutrient management plan should address the following:

- **Nutrient sampling in soil, tissue, and water**—Determine the amount of nutrients in soil and water for early season applications. Use plant tissue sampling for mid and late season nutrient decisions.
- **Timing of applications**—Base nutrient applications on existing nutrient levels and crop nutrient requirements. Optimize nitrogen applications to periods of crop uptake.
- **Fertilizer placement**—Place fertilizer material where maximum plant uptake occurs.
- **Water management**—Use micro-irrigation or sprinklers when applying fertilizers, practice cutback or surge irrigation or tailwater recovery when using surface methods.
- **Vegetation**—Plant grassed waterways and ditches to help remove sediments along with attached nutrients and pesticides. Increased vegetation, including cover crops, can uptake nutrients and prevent them from moving to surface water and groundwater.
- **Application practices—**Maintain equipment and calibration, use backflow prevention devices when applying through water, distribute wash water, and clean up spills.

Another promising management practice for nutrients is the implementation of precision farming. This practice utilizes various tools to tailor the nutrient, water, and cultural practices required for crop production. Precision farming requires that the lands be mapped and managed on a scale that provides an economic return. For example, if a field has both a sandy texture and a clay, the sandy soil will require more frequent, light irrigations than a heavy clay. Customizing the irrigation schedule will reduce the potential for nutrient leaching on the sandy texture.

Pesticide Management

The objective of pesticide management is to reduce the contamination of surface water and groundwater from pesticides. The basic approach is to determine pesticide needs based on pest control needs, crop type, and previous control approaches. Appropriate methods of use need to be followed for mixing, application, and clean up. In addition, proper irrigation water management and erosion control are needed to prevent constituents from moving to groundwater or surface water.

A major tool that is continually refined is integrated pest management (IPM). IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through monitoring and a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties of crops. Pesticides are used only after monitoring indicates that they are needed and according to established guidelines. Treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.

DPR publishes a trend in pesticide use on an annual basis. Analyses of DPR data from 1997 to 2006 have shown that pesticide use varies from year to year, depending on pest problems, weather, acreage and types of crops planted, economics, and other factors. Of the different active ingredient types, insecticides evidenced the greatest increase by pounds; however, the vast majority of this increase was from use of oils. By acres treated, insecticide use increased only slightly. Herbicide use had the next largest increase by pounds and the largest increase by acres treated. Fungicide use (other than sulfur) decreased slightly by pounds but increased by acres treated. Similarly, pounds of fumigants decreased, but acres treated with fumigants increased. (DPR 2006)

Conventional pesticide application technologies such as sprayers are designed for ease of use, not for efficiency. According to the Central Valley Water Board, sprayer studies in orchards show that from 40 to 60 percent of the applied spray goes to the orchard floor, while only 9 to 16 percent ends up on the trees. Aerial pesticide application also can result in a direct drift to surface waters. Volatilization and atmospheric transport of pesticides are likely to affect surface water quality according to a USGS study (U.S. Geological Survey 2002) that documented atmospheric deposition as a transport mechanism during runoff events when precipitation and surface runoff are major sources of stream flow. Several studies by the Sacramento River Watershed Program report that the use of cover cropping reduced pesticide runoff. In one study (Ross et al. 1997) cited by Lee and Jones-Lee (2002), cover cropping in a peach orchard reduced pesticide runoff by 74 percent compared to an orchard with no cover cropping.

The UC Davis website <http://ipm.ucdavis.edu> provides extensive information on how to utilize IPM. In addition, the activities listed below are a component of IPM:

- **Monitoring**—Monitoring requires qualified field personnel to monitor the orchard or field for pests so that treatments are based on need rather than the calendar.

- **Labeling**—Users of pesticides should read and follow all labeling instructions. DPR provides guidance on how to interpret labels; in addition, registered pesticides contain full instructions on how to apply the chemicals.
- **Dormant spray**—Alternating the use of organophosphate (OP) and non-OP sprays helps to prevent resistance in the target pests. There is considerable information on this topic at <http://www.curesworks.org/bmp/almondDormant01.asp>. Other dormant spray practices for orchards include:
  - Restrict applications to ground based only.
  - Do not apply within 100 feet upslope of any sensitive aquatic habitat.
  - Maintain a 10-foot-wide vegetative buffer strip from the edge of field to aquatic sites.
  - Do not apply dormant spray when soil water content is at field capacity and rain is predicted within 48 hours.
  - Apply dormant spray when wind speed is 3–10 miles per hour (mph) at the application site.
  - When wind is >3 mph toward aquatic sites, begin spraying at the side nearest the aquatic site and then move upwind.
  - Shut off spray equipment near the end of rows.
  - Use a larger droplet size, lower pressure, and drift-retardant chemicals in the spray mix.
  - Spray the last three rows upwind of aquatic sites using nozzles on one side only and with the spray directed away from aquatic site.
- **Use of spray adjutants** – Adjutants are additives used in conjunction with a pesticide to increase biological activity and/or modify physical properties of a spray solution. Use of deposition aid and drift control agents as adjutants in pesticide sprays reduces the amount of fine spray particles that carry pesticides out of target areas. It also reduces evaporation of the spray droplets which makes it suitable for use during high temperature, low humidity and low spray volume situations. This can potentially reduce volatilization and atmospheric deposition of pesticides in surface water.
- **Vegetation**—As discussed under “Erosion and Sediment Control” and “Nutrient Management,” vegetation management can result in several beneficial impacts related to pesticide management. Specific vegetation management practices include:
  - Cover crops can adsorb pesticides and prevent them from moving offsite; pesticides also break down faster when adsorbed to vegetation.
  - Spray only around the base of trees.
  - Leave a vegetated strip at the tail end of fields.
  - Roadways can be grassed or sod planted.
  - Filter ditches—areas filled with activated charcoal, peat or other organics—can adsorb pesticides.

Other specific actions that are known to reduce potential impacts on water quality from pesticide and nutrient applications are:

- **Mixing location**—Use an asphalt or concrete mixing pad that drains to a central sump. The mixing location should be at least 100 feet from all water bodies.

- **Equipment—**Continuously check all equipment for cracks and broken components. Spray nozzles should be adjusted for the crop and soil type for which they will be used.
- **Tank filling**—Partially fill the tank prior to the addition of chemical, use the air gap to prevent overfilling, and use a backflow device on the fill tube.
- **Personnel**—Ensure that qualified personnel are mixing and applying chemicals. Trained personnel must be present during tank filling and take corrective action when necessary.
- **Cleanup**—Triple rinse all equipment, apply the rinseate to the field, and clean all equipment at least 100 feet from water bodies.

DPR requires the implementation of specific management practices in Ground Water Protection Areas (GWPA's). GWPA's are those that have been identified as being vulnerable to pesticide movement to groundwater. These areas are designated as either leaching or runoff GWPA's with additional sections of land designated as GWPA's because they contain certain coarse or hardpan soils and have an average depth to groundwater of 70 feet or less. Of the 58 counties in California, 34 contain GWPA's. (DPR 2007)

Irrigation Water Management

Irrigation water management practices are designed to optimize the use of irrigation water for crop production by matching the timing and uniformity of irrigation to the soil water depletion. Over-application of irrigation water can lead to surface runoff and deep percolation. Farm-level practices that can reduce surface runoff include water budgeting, conversion of surface irrigation systems to pressurized systems, and increasing the uniformity of application to prevent excessive deep percolation. When growers use surface irrigation, measures that reduce erosion and surface runoff include tailwater ponds and cutback irrigation. District-level practices that allow a grower to better match supply with demand include increasing delivery flexibility through adjustments to rate, duration, and frequency. Effective irrigation water management practices incorporate the following items:

- **Backflow prevention**—When nutrients and pesticides are used in irrigation systems, proper backflow prevention devices are required to prevent contamination of source water. **Soil water monitoring—**Monitoring soil water depletion through field sensors, California Irrigation Management and Information System (CIMIS), or moisture by feel analysis is important for determining when to irrigate. If the soil water profile is too high when irrigating, deep percolation or surface water runoff may increase. If previous irrigations have sealed the soil surface, it may be necessary to cultivate the furrows to break up the surface skin so that the irrigation water can infiltrate.
- **Application depth**—Proper depth of application is important for preventing the movement of nitrates and other mobile constituents to groundwater. The depth of application is a function of the soil type, irrigation system, and existing soil water depletion.
- **Timing of irrigation—**Proper timing of irrigations reduces crop stress and susceptibility to disease and pest infestation. It also reduces the potential for runoff due to overwatering and thus the likelihood that nutrients or pesticides will be transported off site. Soil water content and the depth of application should be monitored to ensure that irrigations do not occur too early or too late.
- **Drainage management**—Subsurface tile drains can be used to convey deep percolation to a centralized collection point. The effluent of these systems should be monitored to ensure that the

irrigation system is being managed to achieve desired performance and that discharge from these drains does not impact water quality.

Education and Outreach

The objective of education and outreach is to provide end users with information for use in making decisions about which management practices to implement. Education must be tailored to the local conditions, crops, and economics. Outreach needs to be done by individuals who understand local conditions and the effect of the various management practices on the constituents of concern. Many of the commodity groups maintain outreach information regarding current practices for pesticide and nutrient management. Pesticide labeling informs growers on the safe use of pesticides and is considered a form of outreach (labeling is discussed under “Pesticide Management”).

Known Management Practices

Known management practices are those currently being implemented to reduce impacts on water quality. For example, California rice growers prevent the discharge of water that has been treated with certain herbicides. This is a known practice because rice growers must follow product labels and are monitored by county agricultural commissioners. In some cases, such as with rice, the benefit of implementing a practice is known; in other cases, the benefit is unknown.

Water quality coalitions, University of California (UC) Extension, and members of crop commodity groups were contacted and asked to provide quantitative and qualitative information about ongoing management practices, and to discuss ongoing technical support and research. Questions also were asked about ongoing research and implementation barriers. The following six questions were asked of the participants:

1. Are data available that quantifies (or qualifies) the acreage under various practices and can we have it? Can data only on acreage, crop, and management practices be provided (without names, assessor parcel numbers, or any other information that identifies the grower)?
2. What is the benefit and effectiveness of the practice for improving water quality and how is it determined?
3. What practices are being recommended to improve discharge water quality?
4. What practices do you see growers using to improve discharge water quality? Can you estimate the percentage or acreage using a practice?
5. What are barriers to implementation?
6. Are you aware of any studies or research concerning management practices in place and their associated effectiveness? Where can we obtain the study or research results?

These questions were posed to all coalitions, commodity groups, and farm advisors. In addition, available final reports from grants that were funded to provide technical support and research on agricultural water quality issues were reviewed. In most cases, the grants were specific to coalitions and are discussed under the appropriate coalition.

All individuals contacted stated that crop producers in their area are implementing multiple management practices designed to reduce impacts on water quality; however, the extent and performance of the implementation of those practices is not known.

Coalitions

Currently, coalitions conduct monitoring, provide outreach, and develop management plans where agriculture-related water quality problems exist. Coalitions are the Regional Water Board's primary contact to relay information to the growers. Under the current program, the Regional Water Board relies on the coalitions to provide the local oversight.

Association in a particular coalition is primarily based on geography and political boundaries. Coalitions in the Sacramento Valley, the Delta, and the upper east and west sides of the San Joaquin have return flow to natural water bodies. Return flow to natural water bodies generally is not associated with coalitions in the lower San Joaquin Valley and in the Tulare Lake region. In all regions, however, there is deep percolation that—over time—will reach groundwater.

In general, the coalitions understand the types of management practices being implemented to reduce impacts on water quality. Some coalitions have surveyed their growers to determine the types of management practices being implemented. Coalitions also provide support to their members regarding management practices, research, and program requirements. The remainder of this section discusses information that was provided by each coalition.

Sacramento Valley Water Quality Coalition

The Sacramento Valley Water Quality Coalition has compiled a comprehensive report on the evaluation of commodities and appropriate management practices for each commodity. This assessment assigns a priority to the drainage areas that should be targeted in order to promote management practices that reduce impacts on water quality. The coalition is currently conducting surveys about management practices within areas with exceedances of water quality constituents. To remain in the coalition, landowners must complete the survey. Based on the survey results, the coalition expects to compile a database of practices. This information may be available in the future.

California Rice Commission

In November 2004, the California Rice Commission (CRC) provided the Central Valley Water Board with its quality assurance project plan (QAPP) to meet the requirements of Central Valley Water Board resolution R5-2003-0105, conditional waiver of waste discharge requirements. The QAPP describes in detail the steps taken by rice growers to manage constituents. The document provides an inventory of the acreage under monitoring but does not provide an analysis of the acreage participating in management practices.

State mandates and pesticide labeling requirements require rice growers to hold herbicide-treated waters on their fields to allow dissipation or breakdown of herbicides into nontoxic products. The water-holding requirements make it necessary for farmers to carefully control water flow. The three main water management systems that were historically used by rice growers include conventional, recirculating, and static systems. In the past, almost all rice farms were irrigated with conventional flow-through systems where water flows into one “check” or basin and then to the next check. Finally, the water flows out of the bottom check and into a drain. Due to the difficulties in meeting water quality mandates with this type of system, it is not currently used.

Closed systems, such as the recirculating and static systems, are considered the best management practices for holding treated water because they can reduce pesticide residue mass discharge by up to 97 percent over conventional systems. In recirculating systems, water is pumped from the bottom check back to an uphill field, usually on the same farm. Some of these systems have been implemented at the irrigation district level, but most were built by individual farming operations. A static system independently controls inflow into each basin and limits it to the amount required to replenish applied water lost to evapotranspiration and percolation. It also eliminates the possibility of spillage of field tailwater into public drains.

On an annual basis, the CRC maintains information on the amount of chemicals used that have required water-holding time. In an effort to improve the water quality of rice field drain water, growers are adopting closed systems. According to the CRC, the four major rice growing counties (Colusa, Glenn, Yolo, and Butte) show an increase in the use of closed systems from 74,600 acres in 1991 to 136,200 acres in 1994. However, the total number of acres in rice production also increased during the same period. Of the total acreage, closed systems increased from 31.8 to 36.5 percent between 1991 and 1994, while conventional systems decreased from 68.2 to 63.5 percent. The CRC supports all rice growers through technical outreach.

Butte County

As part of a contract, the Agricultural Commissioner of Butte County agreed to provide services to the Central Valley Water Board to support the ILRP. Specifically, the contract was to evaluate a number of agricultural sites and operations, including the coalition’s water quality monitoring sites, and carry out other activities to identify and document management practices that are specific and appropriate to the agricultural operations within the Butte-Yuba-Sutter watershed. The contract also entails an assessment of management practices and their effectiveness to protect water quality.

Many of the current management practices were instituted for economic reasons related to the cost of irrigation; and many of the practices were instituted for soil conservation reasons, not specifically to address water quality issues. However, the identified management practices suggest water quality improvement benefits.

The following summary identifies the key components of the agricultural sites and operations that were surveyed:

- A 14.1-mile length of the creek was surveyed.
- Fifty-four parcels were surveyed.
- Fifty parcels are under an agricultural permit.
- Twenty-three agricultural operations have restricted materials permits.
- A total of 12,332 acres were surveyed.
- A total of 7,944 acres are under cultivation.
- Thirty-nine discharge points were documented.

- Thirteen agricultural operations had discharge points directly to the channel, and all had some form of discharge control device.
- Eight agricultural operations had no observable discharge points directly to the channel.
- Heavy vegetation growth was present at all potential discharge areas.
- One irrigation discharge to Pine Creek was observed.

Walker Creek Watershed Coalition

The Central Valley Water Board contracted with the Walker Creek Watershed Coalition to collect management practices information and to prepare a report on its findings. This watershed was chosen because it is fully contained in Glenn County, and county staff has access to all pesticide use and permitting information that can be used to acquire a grower list and contact information. Results show 140 growers covering 26,755 acres of diversified cropping are present in the watershed. Tillage and vegetation management practices were identified on 98 percent of the acreage surveyed. As part of the information collection process, a pesticide use query was performed to coincide with visual inspection of the agricultural discharger parcels. A total of 228,695 pounds of active ingredients of all pesticides and herbicides were applied within the watershed boundaries from September 2006 through September 2007.

Based on the survey, the coalition concluded the following:

- Although water quality exceedances occurred in the watershed during the study period, an examination of the number of the exceedances reveals that the management practices in place are working to protect water quality. Narrowing the scope for a water quality concern within a watershed is more effective than searching the entire county for a possible cause.
- Visual field assessment surveys can be used as a tool for a subwatershed group if water quality standards are not being met. The survey information can be used to help formulate a management plan or to suggest management practices that can be implemented to alleviate water quality issues. Conducting a watershed evaluation is a more relevant and practical way to determine water quality impacts. When sampling is conducted near the end of the watershed, it provides a good characterization of the watershed. Watersheds also can evaluate management practices for effectiveness or determine whether additional management practices for specific growers need to be encouraged.

Goose Lake Coalition

The Goose Lake Coalition, in Modoc County, is primarily comprised of livestock-forage operations. Although is irrigated pasture is present, they report essentially no pesticide use. They do utilize tailwater ponds, buffer strips, and fencing to reduce the movement of pathogens to water bodies. The coalition received grant funding to restore a river channel and prevent grazing impacts. Organic alfalfa operations are supplying hay to dairies in Humboldt, which appears to be an increasing trend. A barrier to additional implementation of management practices is a lack of available funding.

Delta Water Quality Coalition

The Delta Water Quality coalition is in the process of documenting management measures being implemented to reduce impacts on water quality; consequently, there is no information available concerning the benefits of various management practices to water quality improvements. One of the biggest challenges is to anticipate land use changes and how new cropping patterns need to be managed to reduce impacts on water quality. The use of tailwater return systems and filter strips in the area has increased. Adding Landguard™ OP-A (an enzyme) to water has been shown to dramatically reduce chlorpyrifos runoff (see discussion below under "Westside Coalition"); however, whether the manufacturer will continue to provide the product is questionable. Some areas apply polyacrylimide (PAM) to reduce sediment loading. The coalition is currently considering the use of a farm-assist program, in which growers would work through a workbook that comprehensively reviews the farm operation and seeks to identify where management practices can be implemented to improve operations. The model for this program is being used by the Lodi-Woodbridge Winegrape Growers Association. Target crops include walnuts, alfalfa, tomatoes, and winegrapes. Water quality practices are a component of this effort.

Westside Coalition

As part of their outreach effort, the Westside Coalition supplements traditional grower and Pest Control Advisors (PCA) educational meetings. Called "tailgate meetings," these informal sessions are held with individual large-acreage growers at their farm offices and are facilitated by the Coalition for Urban/Rural Environmental Stewardship (CURES) and either Del Puerto Water District or Central California Irrigation District field staff. Discussed at the meetings are the results of Westside Coalition water and sediment monitoring in Orestimba Creek and Del Puerto Creek, and the requirements for management plans and Westside Coalition members under the ILRP. Also discussed are potential BMPs to address runoff, including results for vegetated ditch and PAM studies performed under this project. Growers are provided literature on several management practices (vegetated ditches; sediment ponds, including a spreadsheet developed by the Westside Coalition to determine holding pond size and dimensions; and pesticide management practices) that are used in the area and show the best potential for affecting runoff.

Management practices that have been quantified for the Westside Coalition include:

- Full operation throughout the 2007 irrigation season of a regional tailwater return system that prevents surface runoff from entering the San Joaquin River and improves water quality and supplies within Patterson ID. This return system intercepts water from the Marshall Road Drain and diverts it into a 65± acre-foot reservoir, where it is returned to the district's irrigation system. Annually, the reservoir collects approximately 2,000 cubic yards of sediment that settled out of the diverted water.
- Construction continued in summer 2007 on a second tailwater return project in Patterson ID, with an expected completion date of 2008. The project consists of a 50± acre-foot reservoir that will collect tailwater and operational spills from five canal laterals that would otherwise discharge into Del Puerto Creek. The project could affect up to 4,500 acres by intercepting tailwater and settling out suspended solids. The project is expected to be operational by the 2008 irrigation season.
- The Westside Coalition distributed a spreadsheet to numerous growers in order to help design tailwater sedimentation ponds that would match field irrigation and cropping practices. As of the current reporting period, at least two ponds have been constructed with assistance from this spreadsheet and a number of others are planned. The spreadsheet is now being distributed by member districts for use by landowners.

- A single farm sedimentation pond was completed in late summer 2007 that will divert irrigation drainage water from approximately 700 acres of orchards and row crops before it enters Ingram Creek. The facility will capture drainage water that will be recirculated to other fields nearby.
- A BMP handbook continues to be distributed to landowners in the Westside Coalition region. The handbook was developed as part of a project to identify and design BMPs for reduction of discharge in the Orestimba Creek watershed.
- Landowners are continuing to install drip and micro-spray irrigation systems. These systems reduce or eliminate irrigation drainage water and subsequent discharges.
- Enzyme treatments of irrigation drain water were made by numerous growers in the Orestimba and Del Puerto Creek Watersheds, according to representatives of Orica Australia Pty, Ltd. Landguard™ OP-A is the enzyme-based technology currently under development for treatment of water contaminated with OP insecticides. In summer 2007, the enzyme was applied into irrigation drainage water after applications of chlorpyrifos in walnut and alfalfa fields. Field trials performed in 2006 demonstrated that Landguard™ OP-A may be an effective BMP for reducing the contamination of agriculture tailwaters following the use of OP insecticides. Further work will continue by Orica in 2008 to better define the optimum dosing rate of Landguard™ OP-A with different crops and developing improved methods for product delivery into drainage water.

Research and BMP evaluations on the Westside include the following three projects.

(1) Use of Vegetated Ditches for Mitigation of Pyrethoid Runoff from Alfalfa

The objective of this study performed in August 2007 was to evaluate the effects of two management practices on concentrations of the pyrethroid, lambda cyhalothrin, in irrigation runoff in alfalfa. The management practices included (1) a standard irrigation return ditch dredged to remove vegetation just prior to the irrigation event; and (2) a specially constructed ditch with resident grasses to provide a dense cover of vegetation for the irrigation event. The study site was a 35-acre commercial alfalfa field near the cities of Crows Landing and Patterson. The concentrations of pesticide were lower in the vegetated ditch than at the inflow or in the conventional ditch, with the mean concentrations for each irrigation event being lower than the inflow concentrations. On average, the median concentration reduction at the end of the vegetated ditch was about 25 percent. The median concentration of lambda cyhalothrin in the vegetated ditch sediment was approximately eight times higher than in the conventional ditch sediment. The concentrations in the vegetated ditch sediment also increased as the water traveled further down the ditch. This indicates that the pesticide drops out of the water (with the sediment) in the vegetated ditch more readily than in the conventional ditch, hence the reason for low detections in the whole water samples. The complete results of this study were submitted to the Regional Water Board in November 2007 as part of the draft final report for the “Western San Joaquin Valley Pesticide BMP Implementation Program” by the San Luis and Delta Mendota Water Authority.

(2) Use of Polyacrylamide (PAM) and Calcium to Mitigate Chlorpyrifos Runoff from Row Crops

This study evaluates the use of PAM in irrigation water after a field is sprayed with chlorpyrifos. Although the study showed that reductions in chlorpyrifos runoff were not significantly different when using PAM and calcium in irrigation water, it did show PAM to be effective in reducing sediment runoff based on visual observation. PAM causes soil particles to aggregate and thereby reduce soil particle movement offsite. Reduced movement of soil particles is quite evident *in vitro* and from observations during the study of irrigation water *in situ*. For pesticides of low water solubility and with a correspondingly high propensity to bind to soil particles, one would expect to see a decrease in the amount of those pesticides moving offsite from fields treated with PAM due to the lack of sediment movement. For pesticides like chlorpyrifos (which is moderately water soluble and has only a moderate tendency to bind to soil), however, the presence or absence of PAM in irrigation water would not be expected to dramatically reduce chlorpyrifos offsite movement under typical conditions.

Work continued in 2007 in a study entitled "Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley," led by William Stringfellow at the University of the Pacific. This project is examining and evaluating three BMPs currently being applied in western Stanislaus County: drainage retention ponds, constructed wetlands, and vegetated ditches. Ponds and wetlands are constructed for the purpose of water recycling, and vegetated ditches are being used as a method to reduce the runoff of sediments and pesticides from fields and farms. The objective of the project is to evaluate the efficacy of these current BMPs for sediment and pesticide control, and to determine the potential effect of the BMPs on other water quality constituents—particularly dissolved organic carbon and nutrients. The overall objective is to determine how these BMPs and similar structures could serve as components of a regional BMP strategy. Also examined are the water quality benefits of vegetated ditches as an end-of-field practice and vegetated drainages as a multi-field mitigation strategy.

A preliminary report on the project stated that, although vegetated ditches and vegetated drainages were effective at removing sediments, end-of-field vegetated ditches presented hydraulic control problems in areas characterized by very little slope. Irrigation return flow conveyed through vegetated drainages showed improvement in water quality compared to return flow conveyed through conventional (dirt-lined) ditches. Although vegetated drainages offer demonstrable water quality benefits, the placement of vegetated drainages throughout the region may not be practical, in part due to land availability and maintenance requirements.

The water quality benefits of ponds and wetlands also were investigated in summer 2007 as part of the project. The study examined whether these recycling facilities have collateral benefits on water quality and if similar structures should be part of a regional BMP strategy. Ponds with and without vegetation were compared to determine whether vegetated systems offer greater water quality benefits than ponds where vegetation is closely controlled. In one study performed in summer 2007, a 12-acre settling pond managed by Patterson ID was evaluated. Drain water from 2000± acres of irrigated cropland flows into the facility. The reservoir is deep (greater than 10 feet) and was designed for sediment removal but is not managed as a biologically active system. Plant growth on pond edges is controlled with herbicides, so vegetation and biological activity are minimal. Water analysis over a 4-month period showed that the pond reduced suspended sediments by an average of 71 percent between the inlet and the outlet. Soluble phosphate also was reduced by 40 percent in outlet flows. The pond, which is drained and excavated each year, traps approximately 2,000 cubic-yards of sediment annually from drainage water. Phosphate is removed by physical processes (settling with sediments) in this pond.

The preliminary report states that the evaluation of constructed BMPs suggests that a regional approach to drainage mitigation would be more effective than a farm-by-farm approach in western Stanislaus County. Vegetated ditches and drainages offer water quality benefits, but will be difficult to implement on scale sufficient to significantly alter the regional environmental impact of irrigated agricultural. Ponds and wetlands have an important role in regional water- recycling and have the potential to serve a water quality control function as well. The efficacy of ponds and wetlands for improving water quality in the region is being further investigated.

(3) Efficacy of Sediment Ponds and PAM for Removal of Pyrethroid Insecticides

A study performed in July 2007 was designed to investigate the effectiveness of sediment basins (with and without PAM) for reducing pyrethroid loading in irrigation drainage water from processing tomatoes in the Orestimba Creek watershed.

A study is planned to evaluate the impact of resident vegetation on pesticide runoff from dormant almonds. The study was scheduled for January 2008, depending on orchard conditions. The study will evaluate the benefits of cultivating native vegetation in almond orchards during the rainy season as a means of reducing pesticide concentrations in runoff. However, low rainfall amounts in fall and early winter 2007 has slowed development of vegetation on the orchard floor, which may inhibit the ability to perform the study.

Grassland Bypass Project

On the westside of the San Joaquin Valley is the Grasslands Drainage Area. The Grassland Bypass Project utilizes a highly coordinated and monitored system to optimize discharge of drainage water with elevated levels of salinity and selenium. There is considerable documentation of the efforts of the Grasslands Bypass Project that is available at <http://www.usbr.gov/mp/grassland/>. This effort is regulated through use of a waste discharge requirements, and lands included in this project are not subject to the current conditional waiver.

The Project prevents discharge of subsurface agricultural drainage water into wildlife refuges and wetlands in central California. The drainage water is conveyed instead through a segment of the San Luis Drain to Mud Slough, a tributary of the San Joaquin River. The Project includes drainage from 97,000 acres of farmland on the west side of the San Joaquin Valley. The California Regional Water Quality Control Board, Central Valley Region, issued Waste Discharge Requirements (WDRs) that specified the maximum monthly and annual loads of selenium that the Project may discharge into Mud Slough and the San Joaquin River. The WDR includes monthly monitoring for molybdenum and nutrients (nitrate, ammonia, total Kjedahl nitrogen, total phosphate, and ortho-phosphate); weekly analyses of salinity, selenium, boron, and other parameters, and chronic toxicity testing. The WDR also outlines a program to monitor storm water releases from the Grassland Drainage Area into the Grassland wetland supply channels should they occur.

Since implementation of the Project, all discharges of drainage water from the Grassland Drainage Area into wetlands and refuges have been eliminated. The Project has reduced the load of selenium discharged from the Grassland Drainage Area, drainage that eventually ends up in the San Joaquin River, by 61percent (from 9,600 lbs to 3,700 lbs). The load of salts has been reduced by 39 percent (from 187,300 tons to 113,600 tons). These efforts have been funded by the farmers that discharge to the San Luis Drain, and the project has been successful largely because of the individual efforts of these farmers. This program was developed around the principal of voluntary actions to meet a regulatory requirement. Intensive monitoring enabled the Grassland Area Farmers to identify where the impairments were originating and the flexibility of the WDR provided a framework where specific management measures could be implemented to control discharges (Reclamation 2005)

Westlands Water District

Westlands Water District does not have a reporting mechanism for agricultural practices information. Westlands works with growers when runoff occurs. They have an active on-farm loan program that provides $4 million annually for the installation of drip and micro-irrigation systems. These systems are primarily being installed on the hilly western area of the district. The loan funding and privately financed installations cover about 8,000 acres per year.

Root Creek Water District

This district is small, and the overhead to operate is greater than the available funding. Although the coalition did survey its members regarding their management practices, the data have not been analyzed. At this point, some of the growers are signing up with the Eastside San Joaquin Coalition. Although nearly all growers are on micro-irrigation systems, a water quality exceedance was recorded in February 2005, resulting from storm water runoff, from an unknown compound.

East San Joaquin Water Quality Coalition

The East San Joaquin Water Quality Coalition provided a limited amount of information on management practices to the Agricultural Commissioner's office; however, they do not maintain the information in an organized manner. The coalition has completed creek walks to identify discharge locations in the region and has met with growers to discuss applicable BMPs. Because the coalition has had some exceedances for chlorpyrifos, they have held meetings with growers to discuss wait times prior to irrigation.

The coalition is trying to document more information with surveys and is working with CURES to obtain BMP information. They distributed 5,052 management practices surveys to selected growers in the coalition region (both coalition members and non-members). The surveys were sent to landowners whose fields were identified by the coalition as being adjacent to or near a waterway monitored by the coalition and where exceedances occurred in 2006. Of the distributed surveys, 200 were returned to the coalition marked as undeliverable, 1,161 were completed and returned, and 3,691 were not returned. While the February 2007 membership stood at 2,486 landowners, more surveys were sent out. One reason is because multiple fields of a single farmer were located near several waterways; these farmers were asked to fill out multiple surveys (not all fields are managed the same due to cropping patterns and irrigation type). Surveys also were sent to non-members whose addresses were obtained through county records. The majority of surveys were completed by coalition members, with a small percentage returned by non-members. The acreage reported on the surveys was approximately 296,162, indicating that approximately 47 percent of the coalition growers returned surveys covering approximately 48 percent of the total enrolled acres in the coalition region.

Of the returned surveys, 995 responses indicated that there was no discharge from their property during either the storm or irrigation season. A large portion of the responses (48 percent) said there was simply no runoff from their property during either season because of local conditions or proximity to waterways. By those who indicated that discharge was a possibility, a variety of management practices are employed to minimize drainage. Each completed survey can contain several management practices; therefore, the number of responses is greater than the number of surveys. Drainage management systems included holding basins, bermed fields, recirculating systems, and sediment settling basins. In addition, 651 respondents indicated that they allowed vegetation growth in drainage ditches in either winter or summer, or both as a means of trapping sediment. When asked about practices used to lessen storm or irrigation runoff from fields to ditches, canals, or streams, 1,269 responses indicated using a variety of practices—including grass row centers in orchards, grass waterways, gravity tailwater recapture systems, and vegetative filter strips—or irrigation management systems such as drip, microspray, sprinkler, or careful water management. A total of 3,456 responses indicated that various management practices were employed to protect surface water quality, including attending commodity-specific training sessions, obtaining a soil nutrient analysis, following a crop nutrient management plan, seeking an agronomist's advice on practices, laser leveling fields, obtaining PCA recommendations, obtaining Certified Crop Advisor recommendations, and performing sprayer calibrations. Only one respondent indicated that no management practices were employed. Over one-quarter of the growers (321) indicated that they had employed a new management practice in 2006, reflecting that growers are making a substantial effort to protect water quality.

Southern San Joaquin Valley Water Quality Coalition

The Kings River Conservation District supports this coalition. They have not collected any quantitative information. There is very little runoff in this region, and much of the runoff that does occur may not reach a water body. Due to the minimal surface drainage, growers feel that less than 10 percent of the acreage is potentially an issue. An existing concern is sediment runoff from furrow-irrigated citrus groves. Growers are responding to that issue by implementing management practices to capture sediments. Growers recognize the potential for pesticides to move to groundwater and are working with DPR to manage the situation. They have requested UC Cooperative Extension to provide field seminars on the use of smart sprayers. These sprayers use technology to sense where the crop canopy is and to spray chemicals at the appropriate locations.

Technical Assistance

Environmental Quality Incentive Program (EQIP)

EQIP provides technical, educational, and financial assistance to eligible farmers and ranchers in order to address soil, water, and related natural resource concerns on their land in an environmentally beneficial and cost-effective manner. The program assists farmers and ranchers in complying with federal, state, and tribal environmental laws and encourages environmental enhancement. The purposes of the program are achieved through implementation of a conservation plan that includes structural, vegetative, and land management practices on eligible land. Contracts from 5 to 10 years are made with eligible producers. Cost-share payments may be made to implement one or more eligible structural or vegetative practice, such as irrigation improvements, filter strips, cover crops, and permanent wildlife habitat. Incentive payments can be made to implement one or more land management practices, such as nutrient management, integrated pest management, and grazing land management.

Because EQIP expenditures are reported at the county level and consequently cannot be assigned to a specific water coalition. The data provided for each practice report the number of projects funded and the sum of the units implemented. For example, conservation cover (the establishment and maintenance of permanent vegetative cover to protect soil and water resources), included five separate actions covering 13 acres, all in the Sacramento Valley in 2002.

County-level detail is available only for 2002. Practice-level data for prior years are unavailable, and data for subsequent years have not been analyzed or posted to the NRCS website. What is known for other years is the level of EQIP effort (Table 5-1). The EQIP funding priorities change annually; therefore, it is not possible to estimate the types of practices implemented in other years. Although the NRCS provides guidance for implementation and estimation of the benefits of each practice, no repository of information reports the benefit.

Table 5-1. EQIP Funding Categories with Potential to Benefit Water Quality

	NRCS EQIP Funding Allocations ($ million)						Local	
Program Category	2000	2001	2002	2003[1]	2004[1]	2005[1]	Share [2]	Total
Statewide Ground and Surface Water Conservation Initiative				9.9	9.2	9.1	112.4	140.5
Other EQIP Expenditures				17.2	26.0	29.7	291.3	364.1
Subtotal	5.8	22.7	16.0	27.0	35.1	38.8	403.6	504.5
Coalition area funding based on 2002 analysis[3]	2.3	9.2	6.5	11.0	14.3	15.7	164.0	205.0

[1] These data are projected from initial allocation ratios, actual data may change.
[2] Local share is assumed at 75 percent of total project cost.
[3] 2002 data were used to determine funding to coalition areas.

Integrated Pest Management

The University of California Statewide Integrated Pest Management Program recently completed a series of seasonal IPM guidelines for almonds, peaches, and plums. The guidelines were created to inform growers and pest control advisors about environmentally responsible pest management. Some of the updated practices include use of pest thresholds to determine when to treat and what type of chemical to use, the promotion of “soft” chemicals over ones that are more toxic, and the promotion of mating disrupters. Not all growers are proactive on pest management issues, and this is a significant barrier to implementing the IPM program. For example, with the increase in almond prices, growers were concerned about maximizing yield and chose to continue with traditional dormant spray routines rather than implementing IPM techniques. In addition, the higher cost of the soft chemicals compared to traditional ones limits their use.

Commodity Groups

Commodity groups are designed as a clearinghouse for technical, research, marketing, and regulatory information for specific crops. Typically, a commodity group only handles one crop—such as the California Almond Board. Phone interviews were conducted with the commodity groups discussed below, using the same set of questions asked to the coalitions. Neither the Dry Bean Board nor the Cherry Board provides outreach materials on water quality issues to their members. The Dry Bean Board stated that they have never provided technical information to their members. The Cherry Board stated that there are no issues such as dormant spray or return flow with this crop. The Dried Plum Board, Pear Board, Specialty Crops Council, Almond Board, Citrus Mutual, CRC, and California Forage and Alfalfa Association all provide significant technical support to their members regarding management practices that are designed to reduce impacts on water quality. The CRC’s support is discussed under “Coalitions.” In addition, many of the commodity groups work with CURES in the East Side San Joaquin Valley Coalition.

California Alfalfa and Forage Association

The California Alfalfa and Forage Association estimates that approximately 400,000 acres of alfalfa in the Sacramento to Modesto region have the potential for runoff with OP pesticides leaving the farm. They feel that growers in the region should switch to pyrethroids because, after the initial year of production, there is generally very little sediment runoff. Another recommended practice is to avoid spraying pesticides in the tail end of surface irrigated fields and in any conveyance ditches. The Association would like to prepare statewide guidelines and was awarded a grant in 2003 for that effort but did not sign a contract because of issues regarding grower confidentiality.

Almond Board

The Almond Board provides outreach to their members through the press and an annual meeting. They are currently updating their online materials in an effort to be more effective. One outreach issue is that the members are on average from 55 to 60 years old and are not frequent users of the internet. The Board is planning on a grower self-assessment similar to what the Lodi-Woodbridge Winegrape Growers have implemented. In part, this assessment helps growers identify management practices that they can implement to reduce impacts on water quality. This effort is about 2 years out.

Dried Plum Board

The Dried Plum Board provides outreach to it members through newsletters and grower meetings. Based on findings from a state-funded grant, they are recommending that growers implement cover crops and filter strips to reduce OP impacts on water quality. One study that was supported by CURES looked at the use of smart sprayers. The results indicate that 50 percent less chemical can be applied if the sprayer is turned off between plants and that only the optimum sections of the plants are treated. Another study that looked at dormant spray timing and intensity found that these sprays could be applied at a lower rate in fall when the soil is dry and before rains begin. This approach has a positive impact because the pesticide is not as susceptible to moving offsite. The Dried Plum Board needs better information concerning aphid monitoring so that IPM could be more effective.

California Citrus Mutual

The California Citrus Mutual provides outreach to its members and to coalitions on management practices that are intended to reduce impacts on water quality. Citrus growers are adopting many of the recommended practices such as greater use of IPM and conversion to micro-spray irrigation. The movement to IPM is partially because of customers' demands for products to be grown with less pesticide use. In Tulare County, where the most acreage is planted, an ordinance to prevent storm water runoff forces growers to implement practices to prevent runoff from their fields.

Cooperative Extension and County Farm Advisors

The UC Cooperative Extension provides crop and water management specialists throughout the Central Valley. These advisors distribute technical information to growers and commodity groups and conduct research on specific issues such as management practices to reduce impacts on water quality. The support ranges from newsletters and field seminars to research into specific areas of concern. Advisors participate in water quality research projects and are aware of the ILRP.

Most advisors report an increase in the amount of drip irrigation and in the use of IPM. New almond plantings in the Sacramento Valley are almost exclusively on drip, whereas drip irrigation accounts for 25 to 30 percent of tomato acreage. Also, many more tailwater recovery ponds, filter strips, and sediment traps are being installed. Growers are utilizing IPM to a greater extent, mainly due to economics. The UC IPM group considers water quality concerns when recommending pesticides. A grant study that was targeted at herbicide management in rice production found that significantly less chemical is needed if the fields were drained and the chemical was applied as a contact herbicide. Another aspect of the study was to look at achieving weed control prior to planting the rice. A barrier that was commonly cited by farm advisors is the financial difficulty for small operations to implement many practices that would reduce impacts on water quality.

Land Use Survey

DWR updates land use information, by county, on a 5-year basis. The land use figures in Chapter 3 present a sample of the land use coverage that is generated by the survey. Included in the update is a description of the type of irrigation method used on the land, any type of water body or conveyance channel, and the source of irrigation water.

Irrigation methods include:

- Sprinkler irrigation—center pivot, linear move, side roll, hand move, permanent, and solid set;
- Surface irrigation—furrow, border strip, basin, and wild flooding;
- Subirrigation;
- Trickle irrigation—surface drip, buried drip, and micro sprinkler; and
- Low Energy Precision Application (LEPA).

In some cases, there are multiple methods of irrigation. For example, it is common to sprinkler germinate field crops and then switch to a surface irrigation method. What is not reported in the database is the presence of tailwater recovery systems or the type of irrigation system used with rice. When the type of irrigation system is specified, there is no indication of the level of management or performance of the system. This is significant because the level of management is a factor in impacts on water quality. For example, a poorly managed sprinkler irrigation system may result in a greater adverse impact to water quality than a well-managed furrow irrigation system. A land use type in the database that would be a direct quantification of a management practice are fields with a cover crop that indicates where grain, field, or pasture type crops have been planted for soil stabilization. However it should be noted that there is no assurance of the performance of the cover crop.

The DWR land use classes that contain a water surface are subdivided into seven categories—three of these categories are significant to the understanding of the connection between irrigated agriculture and water bodies: land use for river or stream channels, channels that are used to convey irrigation water, and channels that are used to remove on-farm drainage water. Connecting irrigation water return flows to drainage could be accomplished by the use of this information set. The information would provide a very good indication of the lands with a surface water connection to drainage or natural water channels.

FUNDING RESOURCES

Statewide Grant Programs

Several statewide grant programs are available to address impacts on water quality. Funding was made available for research, demonstration, monitoring, and implementation projects. Table 5-2 lists recent grants awarded from various sources for implementation projects, education, demonstration and outreach efforts, and applied research.

Table 5-2. Recent Water Quality Grants by Various Funding Agencies

Applicant	Project Title
Education, Demonstration, and Outreach	
Agriculture and Land Based Training Association	Agricultural NPS Reduction: Demonstration, Outreach and Education
Protected Harvest	Common Goals Towards Conservation: Creating a CA Sustainable Processing Workbook
Yolo County Resource Conservation District (RCD)	Yolo-Solano Ag Water Quality Management Support Program
Glenn County Department of Agriculture	Glenn County Surface Water Stewardship
Coalition for Urban Rural Environmental Stewardship	Promotion of Farming Best Management Practices and Calibration Technology to Mitigate Organophosphate Pesticide Runoff into the Sacramento River Watershed
California Prune Board	Implementation of BMP to Mitigate Organophosphate Pesticide Runoff
Implementation	
Sonoma Ecology Center	Plymouth Area Vineyard Erosion Control
California Avocado Commission	Implementation of On Grove Reverse Osmosis to Reduce TDS and Chlorine Impairments
Contra Costa RCD	Application of Beneficial Management Practices to Reduce Runoff from Irrigated Agriculture
El Dorado County RCD	Agricultural Stewardship Project for the South Fork American River Watershed
Grasslands Water District	Adaptive, coordinated real-time management of wetland drainage
Panoche Drainage District	San Joaquin River Water Quality Improvement Project- Reuse Development Project
Patterson Irrigation District (ID)	Real-Time, Salt and Nutrient Drainage Load Reduction Strategies - Patterson & West Stanislaus ID
Reclamation District 800	Lower Kellogg Creek Bio-Filter/Retention Pond Implementation Project
Stevinson Water District	Agricultural Drainage Control Project
Sutter County RCD	Implementation of Feather River TMDL for Orchards
Monterey County RCD	Conversion of Agricultural Drainage Ditches into Treatment Wetlands
Western Shasta RCD	Williams Ranch Tailwater Collection Pond

Applicant	Project Title
The Regents of the University of California, Cooperative Extension (UC Extension)	Upper Feather River Watershed (UFRW) Irrigation Discharge Management Program
Research	
U.S. Environmental Protection Agency, Region 9	Benefits of Vegetated Agricultural Drainage Ditches (VADD) as a Best Management Practice in Yolo County, California
UC Extension	Irrigation Management Measures to Improve the Quality of Surface Runoff Water
California Certified Organic Farmers Foundation	Going Organic Project
Central Coast Vineyard Team	Vineyard Ag Waiver Compliance & Comprehensive Evaluation of Cover Crops to Protect Water Quality
Coalition for Urban Rural Environmental Stewardship	Westside San Joaquin Watershed Irrigated Agricultural Water Quality
Regents of the University of California	Management Practices for Mitigating Off-Site Transport of Soil-Adsorbed Pesticides
San Joaquin County RCD	Measuring the Effectiveness of Agricultural Management Practices
Sustainable Cotton Project	Improving Surface Water Quality in San Joaquin River Basin through Sustainable Cotton Production
UC Extension	Effective Management Practices to Treat and Reuse Agricultural Drainage Waters
UC Davis	Alternative Agricultural Management Strategies to Reduce Runoff and Improve Water Quality
UC Davis	Developing a Water Quality Stewardship for Alfalfa
University of California	Reducing sediment and nutrient loss from commercial vegetable fields
UC Davis	Pheromone Mating Disruption as an Alternative to Organophosphate Use in Walnuts: A Cost Analysis
University of Redlands	Spatial Data Infrastructure to Implement and Monitor NPS Pollution

Proposition 84

The State Water Board is administering a nonpoint source grant program to improve agricultural water quality. The Central Valley Water Board received $8 million of the Proposition 84 bond funds to aid Central Valley farmers in the implementation of management practices necessary to reduce the discharge of pollutants from agricultural operations into surface waters. A public workshop on this funding opportunity was held on September 17, 2008.

Total available grant funds is $8,027,158. The grant distribution is as follows:

- No more than 10 percent of the total grant will be used by the grantee for direct project costs associated with administration and project management of the grant.

- At least 83 percent of the total grant will be spent on individual projects (growers and water districts) that will implement management practices that result in improvement of surface water quality.
- No more than 7 percent of the total grant may be budgeted for technical and consulting services through subcontracts to assist growers and farmers in designing and implementing management practices.

WETLAND MANAGEMENT PRACTICES—SACRAMENTO VALLEY SUBBASINS

Pit River Subbasin

Managed Wetlands

Modoc National Wildlife Refuge

Modoc National Wildlife Refuge (NWR) is located in Modoc County just south of the city of Alturas. The refuge was authorized in 1959 by the Migratory Bird Conservation Commission and presently totals 7,020 acres. The refuge is managed for waterfowl production and migration, and is a major production area for the greater sandhill crane. Approximately 2,000 acres of wetlands are managed on the refuge. Also 2,180 acres of wet meadows are managed for sandhill cranes and Canada goose forage.

Ash Creek Department of Fish and Game Wildlife Area

The Ash Creek Wildlife Area (WA) is located 4 miles northeast of the town of Bieber and consists of 14,754 acres in the heart of Big Valley. The area contains 3,000 acres of natural wetlands and is managed for waterfowl and sandhill crane production and migration. The refuge manages 710 acres of wetlands on seasonal flow from six streams.

Private Wetlands

There are few managed private wetlands in this subbasin. Most private wetlands are maintained as flow-through areas or are re-flooded agricultural fields utilized for waterfowl hunting in fall and winter.

Water Supplies

Modoc National Wildlife Refuge

Modoc NWR utilizes water under diversion and storage licenses from tributaries of the North Fork Pit River (Parker Creek and Stockdill Slough) and Pine Creek, as well as water rights from the South Fork Pit River. USFWS purchased the Dorris Reservoir Unit in 1960. When at full legal capacity, Dorris Reservoir covers 1,080 surface acres and stores about 11,100 acre-feet of water. The refuge has the right to use all of the storage capacity of the reservoir.

The South Fork Pit River supplies are diverted to the adjacent floodplain wetland units when flows are adequate. Diversions are usually possible year-round except at lowest flow periods in July and August. In addition, the refuge has water rights to divert directly from Pine Creek for irrigation and stock water on the south and east management units of the refuge. Total annual water use on the refuge is approximately 11,000 acre-feet.

Ash Creek Wildlife Area

The water supply for the Ash Creek WA is provided by seasonal flows from Ash Creek and five other streams. These flows maintain natural and managed refuge wetlands. The water supply is managed by a flow-through system on an available flow basis, with water returning to Ash Creek downstream of refuge wetlands.

Private Wetlands

Water supplies for private wetlands are not certain for this area. Most rely on spring runoff and additional flows to maintain year-round wetlands. Others may utilize return flows from irrigated pastures and/or wild rice units when available.

Constituents of Concern

Constituents of concern for the Pit River as identified by the CWA 2002 section 303(d) and Central Valley Water Board are nutrients, organic enrichment/low DO, and temperature. The primary potential sources of these constituents are agriculture and grazing.

Current Management Practices

All management practices utilized at the Modoc NWR and Ash Creek WA are intended to maintain and enhance wetland habitat for the benefit of the fish and wildlife resources that occur on each area. However, no management practices are specifically directed to address water quality concerns of discharged water. The current practices include:

- Water levels in wetland units are manipulated to encourage desirable wetland vegetation that will provide food and cover for waterfowl and other migratory water birds.
- Wet meadows at the Modoc NWR are irrigated from April through July annually and then allowed to dry to encourage maximum grass production.
- When mature in late August, the wet meadow grasses are mowed and baled by cooperators who remove the hay from the fields. The grasses are then ready to provide desirable habitat and food for Canada geese and sandhill cranes.
- Water diversion and distribution facilities are maintained to assure proper water flows and depths.

Available Water Quality Information

No direct water quality information for the wetlands supplies or return flows is currently known to be available. A water quality survey for baseline information on alkalinity, CO_2, hardness, DO, pH, and temperature was conducted at eight locations on Modoc NWR in 1996. However the results of this survey are not available from the refuge and will require further research if needed.

The Ash Creek WA does not conduct water quality-related activities. Management activities on both Modoc NWR and Ash Creek WA, as stated above, are intended to manage wetland habitat for the benefits of utilizing wildlife populations; any improvement to water quality would be considered an ancillary benefit.

Colusa Subbasin

Managed Wetlands

Sacramento National Wildlife Refuge

Sacramento NWR is located in Glenn and Colusa Counties, 6 miles south of the city of Willows. The refuge was authorized in 1937 and presently totals 10,783 acres. The refuge is managed as a waterfowl wintering area. Seasonal, semi-permanent, and permanent wetlands are managed for waterfowl and other wetlands-dependent wildlife that utilize the refuge.

Delevan National Wildlife Refuge

Delevan NWR was authorized in 1962; it is located east of the town of Maxwell, in Colusa County. The refuge totals 5,797 acres of uplands, semi-permanent wetlands, and seasonal wetlands. The refuge wetlands are managed for migrating and wintering waterfowl and other wetlands-dependent birds.

Colusa National Wildlife Refuge

Colusa NWR was authorized in 1944 and currently totals 4,956 acres just west of the city of Colusa in Colusa County. The refuge manages seasonal and semi-permanent wetlands for migrating and wintering waterfowl and for several listed threatened and endangered species, such as the giant garter snake.

Sacramento River National Wildlife Refuge

Sacramento River NWR was authorized in 1986; it entails several units along 77 miles of the Sacramento River between the Cities of Tehama to Colusa. The refuge currently consists of 10,000 acres of riparian and floodplain wetlands, as well as walnut, prune, and almond orchards. The orchards are managed by the previous land owner or co-operator and will be until the trees are removed and replaced with native riparian vegetation. The Llano Seco unit contains the only managed wetlands of the refuge. These seasonal wetlands are managed for migrating and wintering waterfowl and shorebirds.

Private Wetlands

The major private wetlands areas in the Colusa Subbasin are located in the Willow Creek and Lurline areas in Colusa County. These areas consist of seasonal wetlands flooded from October through February for wintering waterfowl and recreational hunting. The Willow Creek area is located east of the Sacramento NWR, and the Lurline area is located south of Delevan NWR. USFWS holds conservation easements on 6,000 acres of these private wetlands. The Department of Fish and Game (DFG) also has an active conservation easement program in this basin and has acquired easements on 358 acres to date.

Water Supplies

National Wildlife Refuges

The Sacramento, Delevan, and Colusa NWRs are authorized to receive Central Valley Project (CVP) water supplies per the 1992 Central Valley Project Improvement Act (CVPIA). These water supplies are used to manage refuge wetland units and enhance riparian habitat.

Sacramento River National Wildlife Refuge

The Llano Seco unit contains the only managed wetlands in the Sacramento NWR. Water supplies for this area are provided by the Parrot Ranch under its Butte Creek water right.

Constituents of Concern

Constituents of concern for the Colusa Subbasin as identified by the Central Valley Water Board for the Colusa Basin Drain include the following:

- Azinphos-methyl,
- Carbofuran/Furadan,
- Diazinon,
- Group A pesticides,
- Malathion,
- Methyl Parathion,
- Molinate/Odram, and
- Unknown toxicity.

The primary source of these constituents is agriculture and/or irrigation tailwater.

Current Management Practices

National Wildlife Refuges

Management practices utilized on each of the NWRs in the Colusa Basin are intended to flood and/or maintain several types of wetland habitats and, more recently, to irrigate riparian forest restorations at the Sacramento River NWR. None of the management practices are undertaken to specifically address potential water quality concerns. Management practices that may provide ancillary benefits to water quality include the following:

- Irrigation of seasonal wetland units for waterfowl food production through application of water to encourage plant growth in a unit and allowing water to dissipate through evapotranspiration. This practice is utilized primarily for the production of swamp timothy.

- Manipulation of water levels in wetland units to maximize habitat benefits and encourage desirable vegetation that will provide cover for waterfowl and other migratory water birds. This management practice is utilized on seasonal semi-permanent and permanent wetlands.
- Control of undesirable vegetation and densities is generally conducted through mechanical and controlled fire practices.
- Use of herbicides/pesticides is limited to upland areas, and all chemical use requires completion and approval of pesticide use proposals (PUPs) in accordance with USFWS and Department of Interior requirements. In 2004–2005, 99 acres were treated within the refuge complex. When use of aquatic herbicides in deemed necessary, it is strictly controlled by an extensive list of procedures to ensure that application is conducted only when it is certain that no treated water will leave the confines of the refuge.
- Mosquito abatement is conducted by the appropriate abatement district and is subject to PUP application and approvals.
- Flood-up for fall and winter waterfowl use begins August 1st and continues on a stage basis until full habitat availability is reached, usually by October 1st. Once all desired habitat is flooded, it is maintained on a flow-through basis until draw down is initiated beginning in early March.
- Irrigation for food production is initiated in late April. Swamp timothy units receive a single irrigation each spring, except in dry years. Watergrass and mixed marsh units generally receive two to three irrigations, after which plants are allowed to mature, and then flooded in accordance with a schedule developed each year.

Available Water Quality Information

Water quality information for the NWRs in the Colusa Subbasin is limited. Most of the information is contained in investigations or conducted research associated with waterfowl disease and mosquito abatement activities. The USGS conducted an investigation, *Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the Sacramento National Wildlife Refuge Complex, California* (Investigation Report 92-4036).

In addition, from 1986 to1989, the USFWS National Wildlife Health Laboratory and Northern Prairie Research Center conducted research on avian botulism in waterfowl on the complex. This research involved several environmental quality aspects of the disease cycle; water quality, both supply and wetland water, was included. A number of reports were generated and are available in refuge files.

In cooperation with mosquito abatement districts, the refuge recently has conducted abatement activities research that has targeted impacts on non-target organisms (both single application and cumulative affects) and has involved a number of quality parameter tests. No formal reports have been published.

A wastewater treatment plant is operated at the Sacramento NWR headquarters. The facility is a class 3B and subject to State Water Board regulations and requirements related to water quality and containment. The system is designed to be self-contained; no water is released from the plant into any stream, wetland, or upland. Over the past 5 years, major improvements to the overall system have been implemented, including a 1-acre second evaporation pond.

No water quality information is known to exist specifically addressing the privately owned and managed wetlands in the Willow Creek-Lurline areas.

Butte-Yuba-Sutter Subbasin

Managed Wetlands

Sutter National Wildlife Refuge

Sutter NWR was authorized in 1944 and totals 2,591 acres. The refuge is located in the Sutter Flood Bypass south of Highway 20 and west of Yuba City. The refuge was established to assist in the alleviation of crop damage caused by wintering waterfowl. The refuge is presently managed for this purpose and to provide habitat for wintering waterfowl and other wetlands-dependent migratory birds.

Butte Sink National Wildlife Refuge

Butte Sink NWR was authorized in 1976 and consists of 10,254 acres of conservation easements on privately owned wetlands and 733 acres of fee title wetlands. The fee title area is managed as seasonal wetlands for wintering waterfowl and migratory shorebirds.

Gray Lodge Wildlife Area

Gray Lodge WA, managed by DFG, totals 9,200 acres; 6,300 acres are managed wetlands. The refuge is one of the first wildlife areas established in the Central Valley. It is managed for migratory waterfowl as a wintering area and public hunting and fishing in accordance with State regulations.

Upper Butte Basin Wildlife Area

Upper Butte Basin WA is located west of Gridley, adjacent to Butte Creek. The area totals 9,376 acres of which 6,800 acres are managed wetlands. The WA is composed of three management units: Howard Slough, Little Dry Creek, and Llano Seco. Providing waterfowl and upland game habitat and providing public hunting opportunities are the primary objectives of the WA.

Spenceville Wildlife Area

Spencerville WA is located in Nevada and Yuba Counties, 15 miles east of Marysville. The WA totals 11,448 acres; of these, 81 acres are managed wetlands. The remainder of the area contains foothill oak and grassland habitat. The wetlands are managed to provide water for upland game and habitat for waterfowl.

Private Wetlands (Butte Sink)

Discussion of the Butte Sink NWR occurs above. In addition to the USFWS conservation easements, 8,000 acres of privately owned wetlands are found adjacent to and within the Butte Sink. DFG also has an active easement program in this basin, currently protecting 3,416 acres of the private wetlands. These wetlands are primarily managed as waterfowl hunting clubs. Water in the private Butte Sink wetlands is managed on a flow-through basis to maintain water quality and to minimize effects on salmonids that migrate up and down Butte Creek.

Water Supplies

Sutter National Wildlife Refuge

Sutter NWR is authorized to receive waters supplies from the CVP in accordance with the CVPIA. However, the refuge is awaiting a final conveyance agreement and is currently utilizing the same water supplies available prior to enactment of CVPIA.

The water supply for the 500 acres located outside the Flood Bypass is provided by the Sutter Extension Water District and by groundwater. The Sutter Extension supplies are a firm reliable Feather River supply that is expected to continue. Groundwater is utilized to supplement needs, primarily in late winter.

The water supply for the wetlands inside the Flood Bypass consists of diversions from the East Borrow Channel under USFWS water rights and winter flood flows. Sufficient water flows are diverted to the East Borrow Channel by water managers to meet the needs of diverters from that channel, including the refuge.

Butte Sink National Wildlife Refuge

Water supplies for the 733 acres of fee title lands within Butte Sink NWR are diverted from Butte Creek, the primary water course through the Sink. This water is diverted upstream of the NWR and flows through adjacent private hunting clubs before reaching the NWR. These lands and other wetlands within the Butte Sink are entitled to water supplies in fall and winter in accordance with a 1925 agreement with agricultural and other users upstream of the managed wetlands. In addition, the Butte Sink area is frequently flooded during winter, when high water flows in the Sacramento River and Butte Creek are diverted into the area at the Colusa Weir. These flows continue through the Sink to the Sutter Flood Bypass before co-mingling with Feather River flows and back to the Sacramento River.

Gray Lodge Wildlife Area

Gray Lodge WA is authorized to receive water supplies from the CVP in accordance with CVPIA. Reclamation recently entered into an agreement with the Biggs West Gridley Water District (BWGWD) to convey CVPIA supplies to the refuge. The agreement allows for a 6- to 7-year facility upgrade period before full CVPIA supplies can be delivered on a reliable basis. Therefore, the WA continues to utilize water rights and BWGWD entitlements for primary and secondary lands supplemented by groundwater from refuge wells.

Upper Butte Basin Wildlife Area

The Upper Butte Basin WA water supplies include the Sacramento River and Butte Creek water purchased from the Parrot Ranch, Feather River water purchased from Western Canal Water District and Richvale Irrigation District, and groundwater from WA wells.

Spenceville Wildlife Area

Managed wetlands on the Spenceville WA are provided with water purchased from Nevada Irrigation District.

Private Wetlands (Butte Sink)

The water supply for the private wetlands in the Butte Sink is primarily derived from the 1925 agreement mentioned above in the NWR discussion. This water is diverted from Butte Creek. In addition, groundwater is utilized to meet wetland needs.

Private wetlands adjacent to the Butte Sink rely on agricultural and other wetland return flows to meet water supply needs.

Constituents of Concern

The major constituent of concern for Butte Creek and the Sutter Bypass, as identified in the Central Valley Water Board 2002 section 303(d) list, is diazinon. The potential source for this constituent is crop-related runoff and agriculture.

Current Management Practices

Management practices utilized on the managed wetlands in the Butte-Yuba-Sutter Subbasin are intended to flood and/or maintain several types of wetland habitats and, more recently, to irrigate riparian restorations. Management practices that may provide ancillary benefits to water quality include the following:

- Seasonal wetland units are irrigated in spring for waterfowl food production through application of water to encourage plant growth in a unit and allowing water to dissipate through evapotranspiration. This practice is utilized primarily for the production of swamp timothy.
- Water levels in wetland units are manipulated in fall and winter to maximize habitat benefits and encourage desirable vegetation that will provide cover for waterfowl and other migratory water birds.
- Undesirable vegetation and densities is controlled through mechanical and controlled fire practices.
- Use of herbicides/pesticides is limited to upland areas. All chemical use on USFWS NWRs requires completion and approval of a PUP in accordance with USFWS and Department of Interior requirements.
- Mosquito abatement is conducted by the appropriate abatement districts. The districts conducting abatement activities on NWRs are also subject to PUP application and approvals.
- Flood-up for fall and winter waterfowl use begins August 1st and continues on a staged basis until full habitat availability is reached, usually by October 1st. Once all desired habitat is flooded, it is maintained on a flow-through basis until draw down is initiated beginning in late February and early March.

- Irrigation for food production is initiated in late April. Swamp timothy units receive one irrigation except in dry years. Watergrass and mixed marsh units generally receive two to three irrigations, after which plants are allowed to mature, and then flooded in accordance with a pre-developed schedule.

Available Water Quality Information

Available information for the Sutter and Butte Sink NWRs is found in USGS Investigation Report No. 92-4036, as discussed above for the Colusa Subbasin. The reports developed from the avian disease research discussed for the Colusa Basin also may contain water quality information on the Sutter NWR.

Groundwater currently provides a portion of wetland water supplies at the Gray Lodge WA. DFG measures groundwater levels for both active and inactive wells on a monthly basis and provides the information to Reclamation. Reclamation collects monthly EC, pH, and DO samples from each well used to provide surface supply. In addition, Reclamation tests (1) groundwater for specific conductance, arsenic, chromium, iron, and manganese; and (2) surface water for DO, specific conductance, chromium, hardness, and pH—prior to pumping groundwater and 1 month after pumping stops.

Reclamation is proposing to expand surface water monitoring at major inflow and outflow points for temperature and EC.

WDRs (Order No. 5-01-088) have been issued to DFG for the closed Spenceville Mine at the Spenceville WA. Monitoring is required as part of the Monitoring and Reporting Program for the unsaturated zone; reclaimed pit; and groundwater specific conductance, pH, TDS, TSS, turbidity, alkalinity, hardness, manganese, sodium, potassium, calcium, magnesium, chloride, sulfate, and 11 metals.

DFG purchases approximately 25 miners inches of water per year from Nevada Irrigation District to augment flow in Wellman Creek during the April–October period. This added flow improves water quality below the Farm Ditch in the “1,000 Acre” parcel.

At the Upper Butte Basin WA, Reclamation recently initiated monitoring of groundwater quality at two wells. Specific information on the type of monitoring is lacking at this time.

Solano-Yolo Subbasin

Managed Wetlands

Yolo Bypass Wildlife Area

The Yolo Basin WA is located in the Yolo Flood Bypass east of the City of Davis. The WA manages over 15,830 acres for fish, wildlife, and recreational benefits and includes 4,066 acres of managed wetlands.

Private Wetlands (Conaway Ranch)

Private wetlands in the Solano-Yolo Subbasin are primarily located within the Yolo Flood Bypass. The total amount of private wetlands is estimated at over 17,000 acres. USFWS has a perpetual conservation easement on 4,531 acres of private wetlands. DFG also has an active conservation easement program in the Yolo Bypass, with a total of 1,763 acres under easement. In addition, NRCS has a wetland easement and restoration program under the WRP that has restored and protected over 2,000 acres of former agricultural lands in the Bypass. Several tracts owned and managed by other governmental agencies or non-profit organizations, such as Liberty Island, are areas that have reverted to wetlands due to levee breaches and are subject to tidal fluctuations.

Stone Lakes National Wildlife Refuge

Stone Lakes NWR was established in 1994 and currently manages 4,065 acres within the approved 18,000-acre boundary. A total of 1,400 acres of wetlands are currently managed, with additional wetland restoration planned for the near future. The NWR is in an active acquisition program aimed at meeting the land and habitat protection goals as approved in 1992.

Cosumnes River Preserve

Cosumnes River Preserve was established in 1987. This unique cooperative effort between local, state, and federal agencies and private conservation organizations has acquired over 40,000 acres of habitat, through fee and easement purchases, within the Cosumnes River watershed. The primary goal of the preserve is protection and restoration of the floodplain and associated riparian habitats along the only remaining free-flowing river in the Central Valley. The preserve has created over 1,500 acres of new wetlands, of which 1,080 are managed.

Water Supplies

Yolo Bypass Wildlife Area

The water supply for the Yolo Basin includes water diverted from Putah Creek and the Yolo Bypass toe drain.

Private Wetlands

Water supplies for the private wetlands within the Yolo Basin Flood Bypass are diverted from the toe drain, from the Sacramento River, and through pumped groundwater.

Stone Lakes National Wildlife Refuge

Water sources for Stone Lakes NWR include Morrison Creek, agricultural drainage, North and South Stone Lakes, and groundwater. The refuge also has many small waterways that originate in urban and agricultural areas and empty into refuge wetlands.

Cosumnes River Preserve

Water supplies for the Cosumnes River are dependent on tidal flows. The preserve has a secondary right to pump tidal water for management of the various habitat types on the area, including wetlands.

Constituents of Concern

The constituents of concern for the Solano-Yolo Subbasin are those identified for the Delta Waterways in the CWA 2002 section 303(d) list as identified by the Central Valley Water Board and include the following:

- Chlorpyrifos,
- DDT,
- Diazinon,
- Group A pesticides,
- Mercury, and
- Unknown toxicity.

The potential sources for these constituents are agriculture, urban runoff/storm sewers, and resource extractions (mining).

Current Management Practices

The Yolo Bypass WA does not undertake any wetland management practices that are designed to specifically address water quality concerns for return flows. Water management practices utilized for WA wetlands are similar to those discussed above for the other subbasin wetlands. These management practices may have ancillary benefits to water quality. As with the practices discussed above, habitat maintenance and enhancement are the primary focus of water management on the area.

Water management practices at Stone Lakes NWR are limited by available water supplies. Wetland units are flooded in early fall and maintained through winter. Some wetland units are influenced by tidal fluctuations in North and South Stone Lakes and in Snodgrass Slough.

The Cosumnes River Preserve water management practices depend on available river flows and are utilized in a manner similar to other managed wetlands in the Sacramento Valley. The primary focus of water management practices is the maintenance of wetlands for fall and winter, and restoration of riparian habitat.

Private wetlands are managed as waterfowl hunting areas and are flooded during fall and winter. The area routinely floods each year, inundating wetlands until flows recede in spring.

Available Water Quality Information

Yolo Basin Wildlife Area

The City of Woodland CALFED Bay-Delta Program Watershed Grant Agreement 4600001691 monitored bacteria, boron, metals, organic carbon, pesticides/herbicides, salinity, and total suspended solids throughout the Yolo Bypass, including one site on the Yolo Basin WA. The monitoring occurred over a 1-year period, and the agreement is proposing to produce a water quality management plan to address degradation of surface water.

The Sacramento River Watershed Program Mercury Methylation Study, Proposition 50 Grant, from the State Water Board proposes that water quality monitoring will provide an indication of the extent to which mercury transformation processes in wetlands may affect downstream water quality with regard to methylmercury. Water quality sampling will include selected inflow and outflow sites from the Yolo Basin WA wetlands. Water quality analyses will include filtered and unfiltered total mercury and methylmercury, total suspended solids, major cations, anions, trace metals, nutrients, and dissolved particulate carbon.

Stone Lakes National Wildlife Refuge

Various studies by the Sacramento Regional Wastewater Treatment Plant and USFWS have been completed to date on the refuge and in the surrounding area.

The contaminant assessment was conducted on Refuge waters by USFWS in 1997. The assessment provided known sources of contamination and a survey of potential contaminant sources, pathways, and problems.

Additional USFWS studies conducted in Morrison Creek during 1999 and 2000 found that levels of diazinon were sufficient to kill fish and affect other wildlife after a rainfall greater that 1 inch. The potential source of these pesticides is storm water runoff drainage, flushed through urban stormwater drains.

The Sacramento Regional Wastewater Treatment Plant conducts ongoing quarterly water sampling for certain trace elements from several sites along Morrison Creek, Laguna Creek, Meadowlark Lake, and Black Crown Lake. The USACE sampled water from the Morrison Creek Watershed from 1982 to 1984. Concentrations of cadmium, copper, and lead exceeded the EPA acute toxicity criterion for aquatic life in all samples. DFG and the State Water Board collected and analyzed large mouth bass from Meadowlark Lake from 1985 to 1987 and analyzed for heavy metals and organochlorine pesticides. Elevated levels of mercury, copper, chlordane, dacthal, total DDT, and total PCBs were detected.

Cosumnes River Preserve

University of California, Davis is conducting a remote monitoring program on the Cosumnes River. The overall goal of the monitoring program is to ascertain hydrogeomorphic and ecologic responses to the floodplain restoration program. The program uses levee breaches to reinstate natural processes on former agricultural lands for the purpose of recreating functioning floodplains that also reduce financial losses from floods. The supporting objectives include methodological concerns regarding how to address geomorphic problems with multi-temporal scaling issues, as well as fundamental processes of water, sediment, and contaminant transport on floodplains.

In addition the USGS is monitoring mercury at one sample site on the Preserve as part of a nationwide program. A monitoring site has been established at Twin Cities Road to sample River flows as part of the subbasin compliance with the current Irrigated Lands Waiver Program.

WETLAND MANAGEMENT PRACTICES— SAN JOAQUIN VALLEY SUBBASINS

West Side San Joaquin Valley Subbasin

Managed Wetlands

San Luis National Wildlife Refuge Complex

The San Luis NWR Complex is composed of the San Luis NWR (San Luis, Kesterson, and West and East Gallo units), San Joaquin River NWR, and Merced NWR (Merced and Arena Plains units). Although the Merced NWR is located east of the San Joaquin River, it is included here to maintain the continuity of discussion of the overall NWR complex. The refuge complex totals approximately 43,000 acres. These refuges manage over 150 separate wetland units totaling 9,000 acres. The balance of the lands consists of native uplands, floodplains, vernal pools, riparian forest, and 1,974 acres of cropland.

Los Banos Wildlife Area

Los Banos WA was established in 1929 as the first of a series of waterfowl refuges established throughout the state for wintering waterfowl. The WA currently totals 6,217 acres of wetland habitat composed of lakes, sloughs and managed marsh. The refuge is located 4 miles northeast of the City of Los Banos in Merced County.

Volta Wildlife Area

Volta WA is located 0.75 mile north of the town of Volta in Merced County. The area totals 2,891 acres of managed marsh and valley alkali shrub. The area is managed as a wintering area for waterfowl and shorebirds.

North Grasslands Wildlife Area

The North Grasslands WA is comprised of the China Island Unit, the Salt Slough Unit, and the Gadwall Unit. The three units are close to the Cities of Los Banos and Gustine. The WA totals 7,069 acres of wetlands, riparian habitat, and uplands that are managed for wintering waterfowl, Swainson’s hawk, and sandhill cranes.

Grassland Resource Conservation District

The Grassland RCD is comprised of the Grassland Water District (GWD); San Luis NWR; and Los Banos, Volta, and North Grassland WAs. The private lands within the Grassland Water District and RCD are hunting clubs totaling approximately 70,000 acres, of which about 39,000 are managed wetlands.

USFWS has an active conservation easement program in the RCD and has acquired easements on over 50,000 acres to date. DFG also has an active easement program within the San Joaquin River Subbasin and has acquired 994 acres of easements to date.

Water Supplies

The water supplies for the San Luis and Merced NWRs, Los Banos and Volta WAs, and the Grassland RCD are authorized by the CVPIA and provided by Reclamation from the CVP. However, the Merced NWR receives water supplies from the Merced Irrigation District as mitigation for the New Exchequer Dam and also utilizes groundwater supplies.

Constituents of Concern

Constituents of concern for the Westside drainages as identified by CWA 2002 section 303(d) and the Central Valley Water Board include:

- Chlorypyrifos,
- Diazinon,
- EC,
- Selenium,
- Boron,
- Azimphos-methyl,
- DDE,
- Group A pesticides,
- Mercury,
- Sediment, and
- Unknown toxicity.

Table 5-3. CWA 303d List of Impaired Water Bodies near the West Side San Joaquin Valley

Waterbody	Constituent	Potential Sources
Del Puerto Creek	Chlorpyrifos, diazinon	Agriculture
Grassland Marshes	Electrical conductivy (EC)	Agriculture
Ingram Hospital Creek	Chlorpyrifos, diazinon	Ag return flows
Mendota Pool	Selenium	Agriculture, agricultural return flows, groundwater withdrawal, other
Mud Slough	EC, selenium, boron, unknown toxicity, pesticides	Agriculture
Newman Wasteway	Chlorpyrifos, diazinon	Agriculture
Orestimba Creek	Unknown toxicity, chlorpyrifos, diazinon, azinphos-methyl, DDE	Agriculture
Panoche Creek	Selenium, mercury, sediment	Agriculture, grazing, roads, mining
Salt Slough	EC, boron, unknown toxicity, chlorpyrifos, diazinon	Agriculture
San Joaquin River		
Bear Creek to Mud Slough	EC, boron, unknown toxicity, chlorpyrifos, diazinon, Group A pesticides, DDT, mercury	Agriculture, mining
Mendota Pool to Bear Creek	EC, boron, unknown toxicity, chlorpyrifos, diazinon, Group A pesticides, DDT	Agriculture
Merced River to South Delta Boundary	EC, boron, unknown toxicity, chlorpyrifos, diazinon, Group A pesticides, DDT, mercury	Agriculture, mining
Mud Slough to Merced River	EC, selenium, boron, unknown toxicity, chlorpyrifos, diazinon, Group A pesticides, DDT, mercury	Agriculture, mining

Current Management Practices

Existing Water Quality Monitoring

San Luis National Wildlife Refuge

Hourly flow and salinity data were collected throughout 2002 and 2003. Only one inlet and three outlets were instrumented in the San Luis Unit of the refuge complex. Of these, adequate data were obtained at only two of the outlets.

Grassland Water District

A more comprehensive monitoring network has been operational in GWD for the past 4 years. The monitoring network comprises both inlet and outlet sensors measuring flows and salinity, data are transmitted hourly to a satellite and made available to water managers on a district website.

Participation in the SJV Westside Coalition

The Grasslands wetland entities have chosen to become part of the San Joaquin Valley Westside Coalition in order to comply with monitoring guidelines developed for the Agricultural Waiver Program. A watershed conditions document that describes the unique characteristics of the wetlands and a monitoring program plan document that justifies the selection and monitoring frequency of the sites chosen for the program were filed by wetland signatories to the coalition.

Water Management Plans (5 year and yearly updates)

Focus on methods to improve water use efficiency and water quality on refuge water management plans should be revised as more data become available to characterize current conditions on the various wetland areas that make up the Grassland Ecological area. The water management plan updates should strive to document what constitutes a BMP relevant to each major wetland function and allow these practices to be refined, together with quantitative measures of water use, irrigation timing, and drainage management. Each updated water management plan also should include updates on quantitative measures of habitat quality to provide a baseline against which improved management practices and the result of their application can be compared.

Groundwater Wells

Groundwater wells were installed in the refuges as a hedge against water shortages. Wells yielding water of acceptable quality (typically below 1,500 ppm TDS) are used conjunctively in refuges such as the San Luis NWR to supplement existing water supply. Wells in the State-managed wetlands are less frequently used owing to the added cost of groundwater pumping. There are no District-owned production wells in the GWD. Domestic wells within the District service local duck clubs.

Grasslands Drainage Pilot Study

The State Water Board has provided funding for a pilot implementation study of real-time water quality management in the Grasslands Ecological area. The study will comprise three paired sites in the GWD and State WMAs. These paired sites include a control site that will be managed using traditional techniques for a period of 3 years and a treatment site that will be managed traditionally in year 1 and practice delayed wetland drawdown (between April 15 and May 15) in years 2 and 3. Inlets and outlets of each pair of sites will be instrumented, and the telemetric data sent to the water master's office. Water monitoring will occur within each wetland to develop relationships between ambient wetland salinity and outlet salinity. Habitat assessment methodologies will be refined and implemented during each year of the study to provide a quantitative measure of the impacts of real-time water quality management implementation.

Available Water Quality Information

Recent studies and monitoring of water quality in the area west of the San Joaquin River include:

- USFWS studies of selenium contaminant levels in migratory birds (1989 and 1994).
- Operational USFWS Selenium Monitoring of Mud Slough and Salt Slough (1989–1995).
- "Selenium in the Ecosystem of the Grassland Area of the San Joaquin Valley: Has the Problem Been Fixed?" (2004).

- "Salinity, Boron, and Nutrient Monitoring of Wetland Source Waters and Discharges at the San Luis National Wildlife Refuge Complex" (2002).
- "Evaluation of the Effects of Management of the San Luis National Wildlife Refuge Complex Wetlands on the Dissolved Oxygen Problem in the San Joaquin River Deep Water Ship Channel" (2004).
- Grassland Bypass Project (1996–present).
- The Grassland Bypass Project is an innovative program that was designed to improve water quality in the channels used to deliver water to wetland areas. Prior to the project, subsurface drainage water was conveyed through those channels in route to the San Joaquin River (see previous discussion on page 5-18).
- Westside Drainage Coalition (2003–present)

California Department of Fish and Game—Los Banos Wildlife Area

Electrical conductivity measurements have been taken by DFG staff at eight major intake locations and two major drainage locations along Mud Slough periodically between January 2001 and November 2004.

Beginning in March 2005, monitoring resumed on a bi-weekly basis. As part of the Conditional Waiver, several sites are monitored near the Los Banos WA. Salt Slough at Sand Dam is monitored by the Westside Coalition, sampling for general physical characteristics, water column toxicity, sediment toxicity, drinking water constituents, and pesticides. Boundary Drain is monitored by the San Luis Canal Company upstream from the WA boundary. This site is a real-time monitoring station collecting data on EC and stage. USFWS maintains a real-time monitoring station on Salt Slough at Wolfsen Road that collects continuous data on temperature, flow, and EC.

Volta Wildlife Area

In March 2005, DFG staff began measuring EC at two major intake locations, a major drainage into the Volta Wasteway and the two major drainage locations at the WA boundary. A real-time monitoring station along the Volta Wasteway has been maintained by GWD since 2002 and continues to be monitored as part of the Conditional Waiver. GWD also conducts monthly grab sampling at this location for boron and selenium.

North Grasslands Wildlife Area—Salt Slough Unit

DFG staff have taken EC measurements at seven major drainage locations periodically since 2001. As part of the Conditional Waiver, several sites are monitored near the Salt Slough Unit. USFWS maintains four sites nearby that monitor general physical parameters, organic carbon, and several other constituents.

North Grasslands Wildlife Area—China Island Unit

Currently, only one monitoring location (near China Island) is maintained by the Westside Coalition as part of the Conditional Waiver. The site is located in the Newman Wasteway; however, the WA does not receive or discharge water into the Wasteway.

U.S. Fish and Wildlife Service—San Luis National Wildlife Refuge

Hourly flow and salinity data were collected throughout 2002 and 2003. Only one inlet and three outlets were instrumented in the San Luis Unit of the refuge complex. Similar monitoring systems will need to be installed at the inlet and outlets of the other management units of the San Luis NWR complex as well as in the state WA complex. Adequate resources need to be devoted to station maintenance in order to ensure data quality.

Grassland Water District

A more comprehensive monitoring network has been operational in the Grassland Water District (GWD) for the past 4 years. The monitoring network comprises both inlet and outlet sensors measuring flow and salinity. Data are transmitted hourly to satellite and made available to water managers on a district website.

GWD also has the following information on file:

- Grassland Water Task Force—Water Quality Analysis/Monitoring Reports 1985–1995; required by the Central Valley Water Board Program Nos. SJR001-SJR016.
- “Water Quality Impact of Wetlands on San Joaquin River, California,” L. Grober, J. Karkoski, and T. Poole; 1994.
- Grassland Water District Drainage Operation Plans, 1989–c.1994; required by Central Valley Water Board.
- Inland Surface Water Plans, 1992–c.1994; required by Central Valley Water Board.
- “Real Time Water Quality Management in the Grassland Water District,” Nigel Quinn et.al, December 2004 (covers the period from 2001 to 2004).
- Grassland Bypass Project, Monthly water quality monitoring and reporting 1996–current; data compiled by San Francisco Estuary Institute.

East Side San Joaquin Valley Subbasin

Managed Wetlands

Merced National Wildlife Refuge

Merced NWR was authorized under the Lea Act in 1944 and currently totals 8,358 acres. The Merced Unit of the refuge manages 1,550 acres of seasonal wetlands, 88 acres of semi-permanent wetlands, and 41 acres of permanent wetlands. In addition, the unit manages 40 acres of irrigated pasture and 453 acres of cropland.

The Arena Plains Unit totals 2,460 acres, which includes 222 acres of non-irrigated seasonal wetlands and 275 acres of semi-permanent wetlands.

Private Wetlands

Private wetlands east of the San Joaquin River are found on several private hunting clubs and large ranches south of Highway 140, north of Sandy Mush Road, and west of Highway 59. USFWS has conservation easements on approximately 12,000 acres, and recently acquired 2,000 acres that will be managed by the Merced NWR as the Sno-bird unit.

Water Supplies

The Merced NWR unit is authorized water supplies in accordance with the CVPIA. Because there are no facilities for delivery of CVP water, refuge supplies are provided by the Merced Irrigation District (MID), water rights on Duck and Deadman Sloughs, and groundwater. MID water is available only during the irrigation season (April–October). Fall and winter supplies rely on groundwater and water right diversions to maintain flooded wetlands.

The Arena Plains Unit water supplies are diverted under water right permits from the Atwater Drain and Bear Creek.

Private wetland water supplies are provided by groundwater, various water rights held by the landowners, and purchased water from neighboring water districts.

Constituents of Concern

Constituents of concern as identified under the CWA 2002 Section 303(d) for Bear Creek and the San Joaquin River from Bear Creek to Mud Slough are listed as follows:

- Boron,
- Chlorpyrifos,
- DDT,
- Diazinon,
- EC,
- Group A pesticides,
- Mercury, and
- Unknown toxicity.

Potential sources for these constituents are agriculture, resource extraction, and unknown.

Current Management Practices

Management practices for this area are essentially the same as those discussed above for the managed wetlands west of the San Joaquin River.

Available Water Quality Information

There is no information on water quality that is specific to the Merced NWR and private wetlands east of the San Joaquin River. Some of the studies discussed for the San Luis NWR may have data relative to Merced NWR.

Wetland Management Practices—Tulare Lake Subbasin

Managed Wetlands

Kern-Pixley National Wildlife Refuge Complex

Kern NWR was established in 1960 and consists of 10,618 acres of managed wetlands, riparian, and upland habitat. A total of 6,185 acres are managed as seasonal wetlands.

Pixley NWR was established in 1959 and consists of 6,192 acres. A total of 4,392 acres is set aside as endangered species habitat. Currently, approximately 400 acres of seasonal wetlands are managed on the refuge. The remaining 1,400 acres are managed as non-irrigated uplands and dry wetlands.

Mendota Wildlife Area

Mendota WA, located in Fresno County, consists of 11,800 acres of floodplain and managed wetlands habitat. The area is managed as a wintering area for migratory birds and for public hunting.

Private Wetlands

Private wetlands in the Tulare Lake Basin currently consist of approximately 3,000 acres of private hunting clubs primarily located north and east of the Kern NWR. In addition, NRCS has restored approximately 2,000 acres of former agricultural lands under the WRP. These wetlands are protected by conservation easements held by the USDA.

Water Supplies

Water supplies for the Kern NWR are authorized under the CVPIA and conveyed to the refuge by the Buena Vista Water Storage District.

Water supplies for Pixley NWR also are authorized under the CVPIA. Pending completion of a conveyance agreement and construction of facilities, the refuge is utilizing groundwater for the management of wetland units.

Water supplies for the Mendota WA are authorized by the CVPIA and are delivered by Reclamation through the Mendota Pool to Fresno Slough, where the water is then diverted onto the WA.

Water supplies for the private wetlands depend almost entirely on groundwater. During above-normal and wet hydrologic years, surface supplies may be available from local water storage districts such as the Semi-Tropic Water Storage District.

Constituents of Concern

No CWA Section 303(d) constituents have been identified for the Tulare Basin waters adjacent to the Kern and Pixley NWRs or private wetlands.

Selenium is a recognized constituent of concern at the Mendota WA, along with TDS and EC.

Current Management Practices

When Kern NWR has sufficient or excess water and permission from downstream landowners, the refuge utilizes a flow-through management practice to reduce the level of salts in impounded water. These flows are then released and utilized downstream on agricultural lands.

Inflow water is monitored to ensure that it is not excessively high in salts and other organic or inorganic compounds. Monitoring is conducted to ensure that water utilized on the refuge is the highest quality possible.

With the increase in reliable water supplies through the CVPIA, Kern has reduced the level of water recycling due to improved water quality. This should somewhat reduce the salt load in the water that may be released from the refuge.

The majority of water utilized on Kern NWR evaporates or percolates into the soil. The relatively small amount of water that is discharged is utilized on adjacent farmland or seeps into the soil in the Goose Lake Canal.

On Pixley NWR, the wetland units are also used for groundwater recharge; thus no waters are discharged off the refuge. On the private wetlands, water is applied in early fall and winter for waterfowl hunting. Following the close of the hunting season, water is allowed to evaporate and percolate into the soil.

Management practices at the Mendota WA are directed toward maintaining quality wetland habitat for migrating and wintering migratory birds, primarily waterfowl and shorebirds. These management practices are similar to those of other managed wetlands in the Valley.

Available Water Quality Information

Kern NWR monitors twice yearly for the following constituents: DO, EC, molybdenum phosphorus, pH, TDS, boron, sodium, arsenic, and selenium. Reports are available in the refuge files.

DISCUSSION

The total acreage of managed wetlands in the Central Valley Watershed from Modoc NWR in the north to Kern NWR in the south is about 144,000 acres. These wetlands are principally located in the lower elevations of the various subbasins in which they occur. These low areas have traditionally served as the receiving lands for return flows from upland water users. This is especially true following the major alteration to historical flows for flood control and agriculture.

Water quality has been a concern of wetland managers for more than 50 years. This concern, however, was focused on water being used to manage wetlands rather than waters being discharged to downstream rivers. As a result, limited information is available about the water quality of wetland discharges. The majority of the available information is for wetlands in the Westside San Joaquin River Subbasin; San Luis NWR; Grassland RCD and Volta, Los Banos, and North Grassland WAs.

The CVPIA has resulted in a beneficial effect on water reliability, quality, and management for a major portion of Central Valley wetlands. For the most part, the quality of water available for wetland management has improved. Wetlands nationwide have been known as natural filtering systems for many constituents; it is anticipated that, over time, the wetlands’ authorized supplies for the CVPIA also will result in improved quality of return flows.

The management practices that are utilized by wetland managers are essentially uniform throughout the Central Valley. The primary management objective is to provide quality wetland habitat for migrating and wintering populations of migratory birds, primarily waterfowl and shorebirds. Therefore, management practices are focused on meeting that objective. The principle type of wetlands managed are seasonal wetlands, either irrigated for waterfowl food production (swamp timothy/watergrass) or non-irrigated. Irrigated seasonal wetlands receive water one to three times between April and June each year, depending on the food plants desired and geographic location of the area. These wetlands, along with non-irrigated seasonal wetlands, are then flooded in early fall and maintained through the winter until February or March, when they are gradually drawn down to achieve desired soil temperatures for germination of desired food plants.

Other wetland types being managed include permanent year-round marsh units and semi-permanent wetlands. The semi-permanent wetlands, also known as brood ponds, are usually dewatered for 2–3 months around July of each year and may be re-flooded for the fall and winter waterfowl migrations. These two wetland types comprise about 10% of the total wetlands in the Central Valley Watershed.

Typical management of wetlands in past years did not consider the quality of return flows as a principle focus of any of the standard management practices. With a few minor exceptions, this is still the existing condition today. To better understand the water quality of return flows and whether wetlands and wetland management practices are impacting that quality, monitoring of inflow and outflow waters may be desirable. However, some wetland managers feel that, due to the location of wetlands throughout the Valley and the public trust responsibilities for the resources that utilize them, wetlands should be considered receiving waters of the State. Thus, water supplies that flow to and through wetlands and are used for their management should be held to the same standards as other receiving waters within the subbasin in which the wetlands are located.

Overall, the primary finding of the current existing conditions for Central Valley managed wetlands is that the information on water quality can be found where concerns have existed for many years. The information is primarily found for wetlands in the Westside San Joaquin River Subbasin. All the other subbasins have very limited information, if any, and management practices are not focused on improving the quality of discharged waters. Nevertheless, some management practices may result in ancillary benefits to wetland return flows. A more in-depth review, as the Water Quality Program moves forward and the expected EIR is developed, may help in determining the overall role of wetlands in the larger-scale management of water supplies throughout the entire Central Valley Watershed.